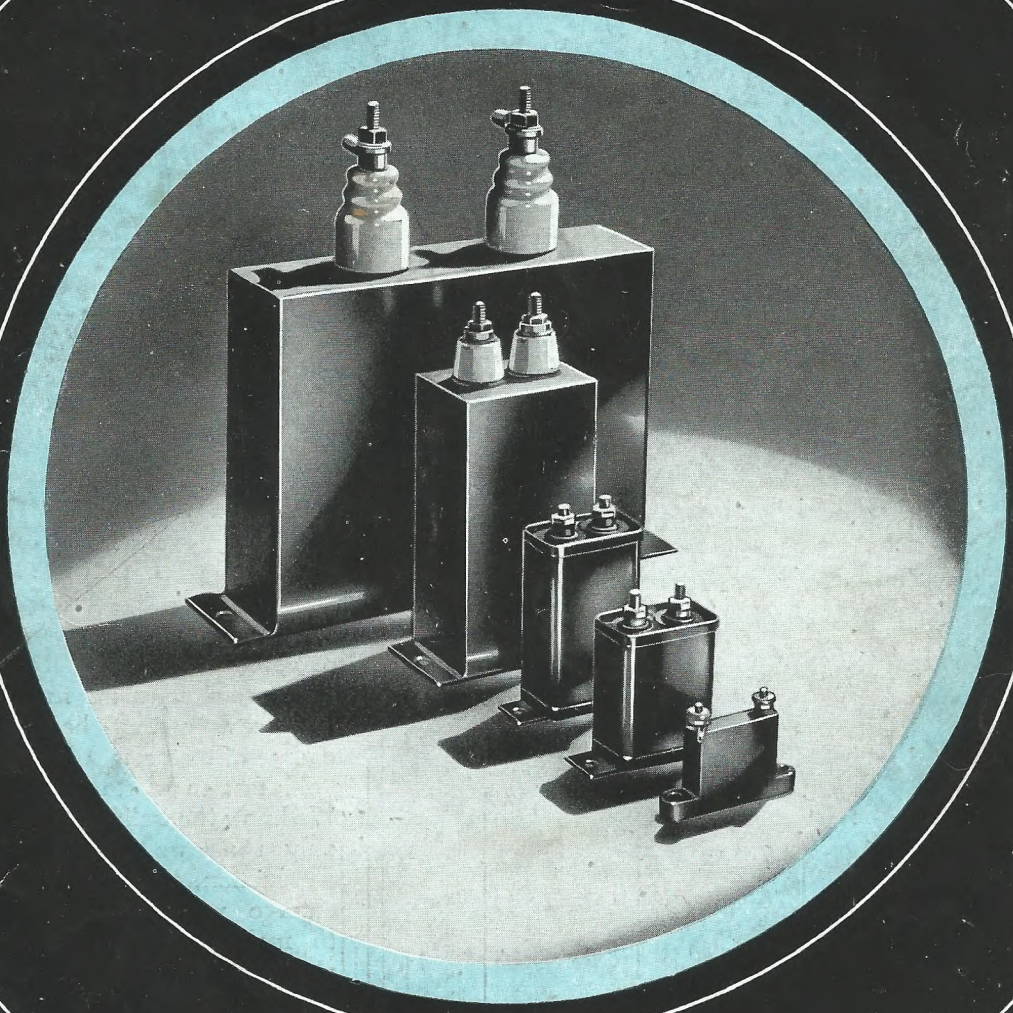
Wireless World

RADIO • ELECTRONICS • ELECTRO-ACOUSTICS



JULY 1942

1/3

Vol. XLVIII No. 7

MAKING A MOVING-COIL PICK-UP

From the fiery FURNACES . . .

. . . of Britain's factories, from her shipyards and laboratories and mines has come many an invention, many a discovery that has changed the course of history. We search for and hold fast to whatever good we can. We know full well that by perseverance only shall we blot out hatred and destruction, misery and hardship and emerge with a fierce determination to make the world a better, safer place. It is our wish always to be associated with that spirit of true comradeship which shall be continued on through happier days.

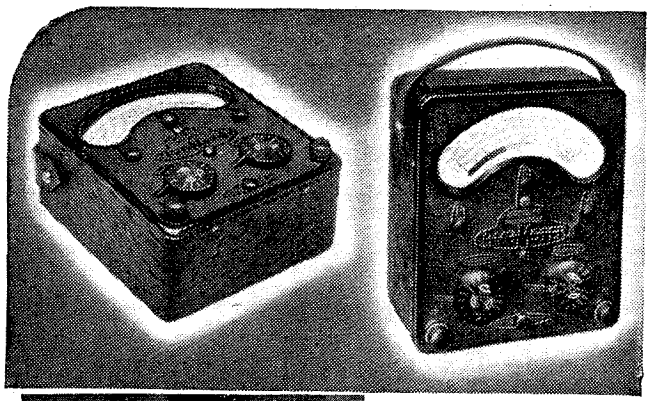
DUBILIER
CONDENSER CO. (1925) LTD.

C.R.C.162

Pollard

46-range Model 7
Universal AvoMeter

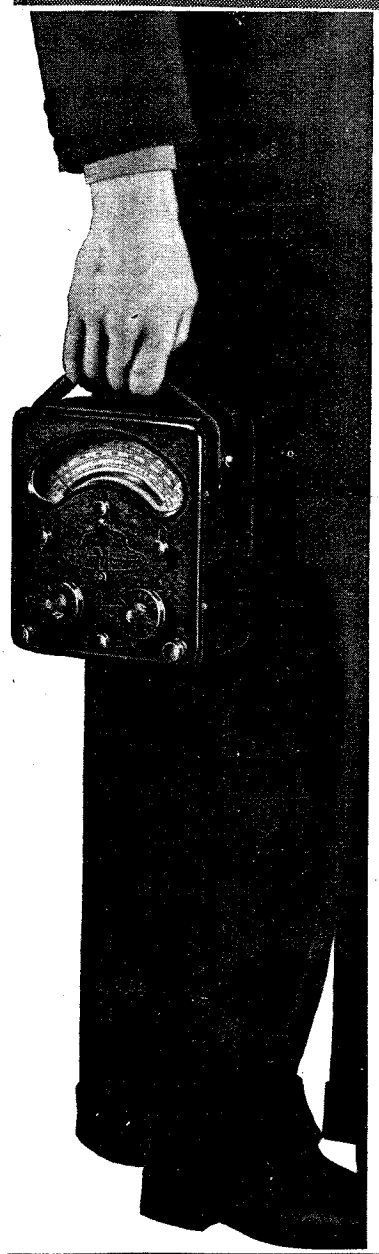
40-range Model 40
Universal AvoMeter



'AVO'

Regd. Trade Mark

Meters that Matter



In every sphere of electrical test work . . . in the laboratory, the workshop, the service engineer's bench or "out on a job," . . . the word "AVO" is synonymous with instruments of precision.

The "AVO" range embraces instruments for every essential electrical test. By reason of their reliability and maintained accuracy, even under the most searching of workshop conditions, they are frequently used as a standard by which other instruments are judged.

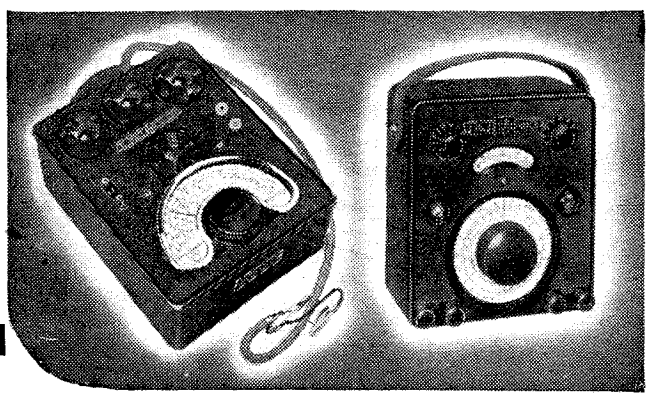
Write for literature fully descriptive of any "AVO" Instrument in which you are interested.

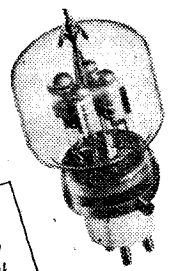
Sole Proprietors and Manufacturers:
THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT Co. Ltd
Winder House, Douglas Street, London, S.W.1. *Phone: VICtoria 3404-7.*

Some delay in delivery of Trade orders is inevitable, but we shall continue to do our best to fulfil your requirements as promptly as possible.

All-Wave "Avo" Oscillator

"Avo" Test Bridge





Ahead Today
The multiunit triode is today in fact what many thought could only exist in theory.

Everlastingly seeking improvements in the performance capabilities of the vacuum valve. That's the creed of the personnel in the Eimac shops. That's why you find Eimac valves in the key sockets of practically every new development in the field of electronics, why communications men throughout the world have come to measure results in terms of the performance capabilities of Eimac valves. This high standard of excellence was deliberately planned at Eimac... and is being deliberately maintained despite the rigors of wartime production.

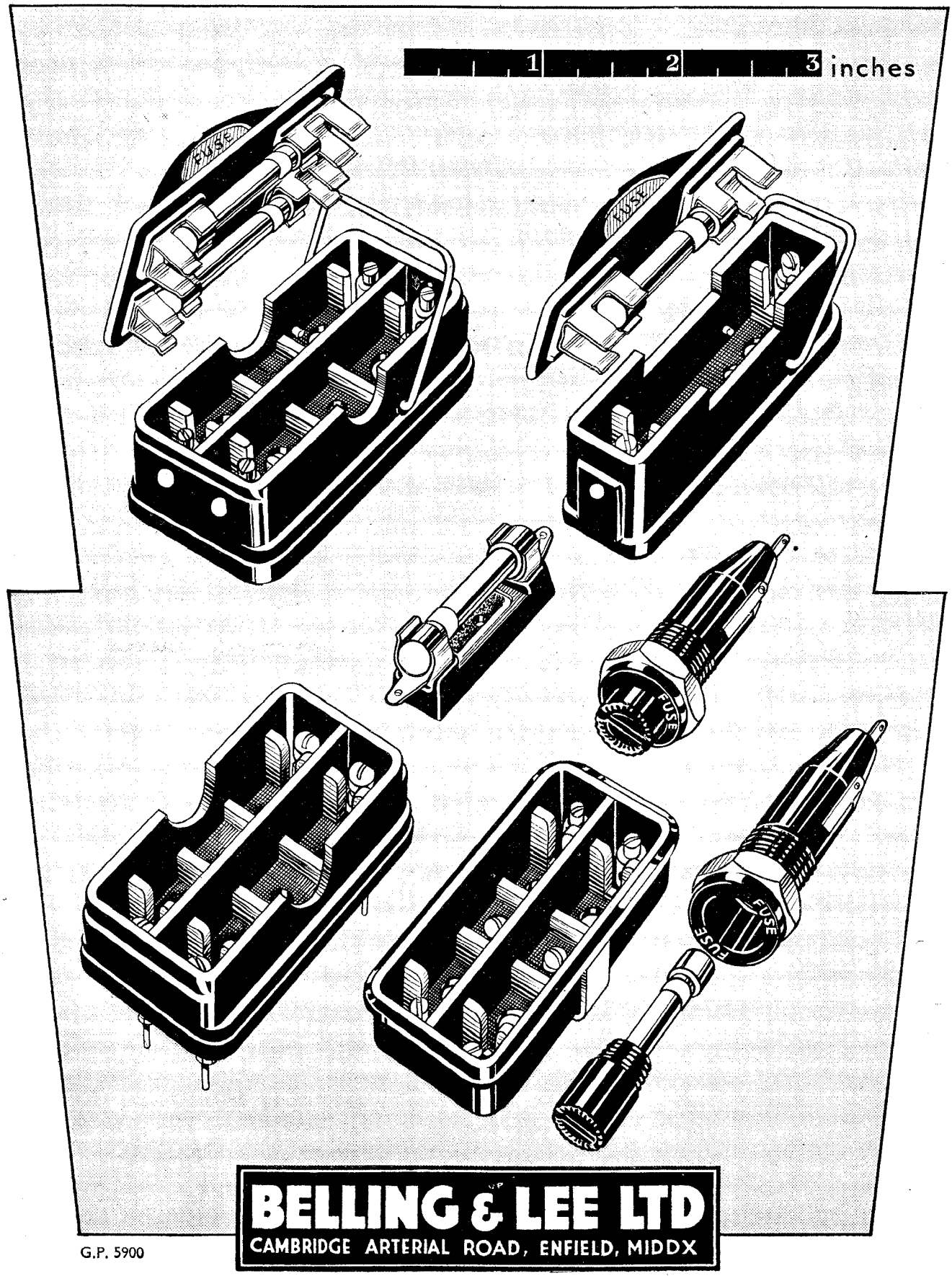
You've found Eimac ahead in the past... they're ahead today... and you'll find them still ahead in the future

Ahead in the Future
Certain new achievements cannot be revealed. Others are in the making. Rest assured that Eimac is keeping ahead.

Follow the leaders to

Eimac VALVES

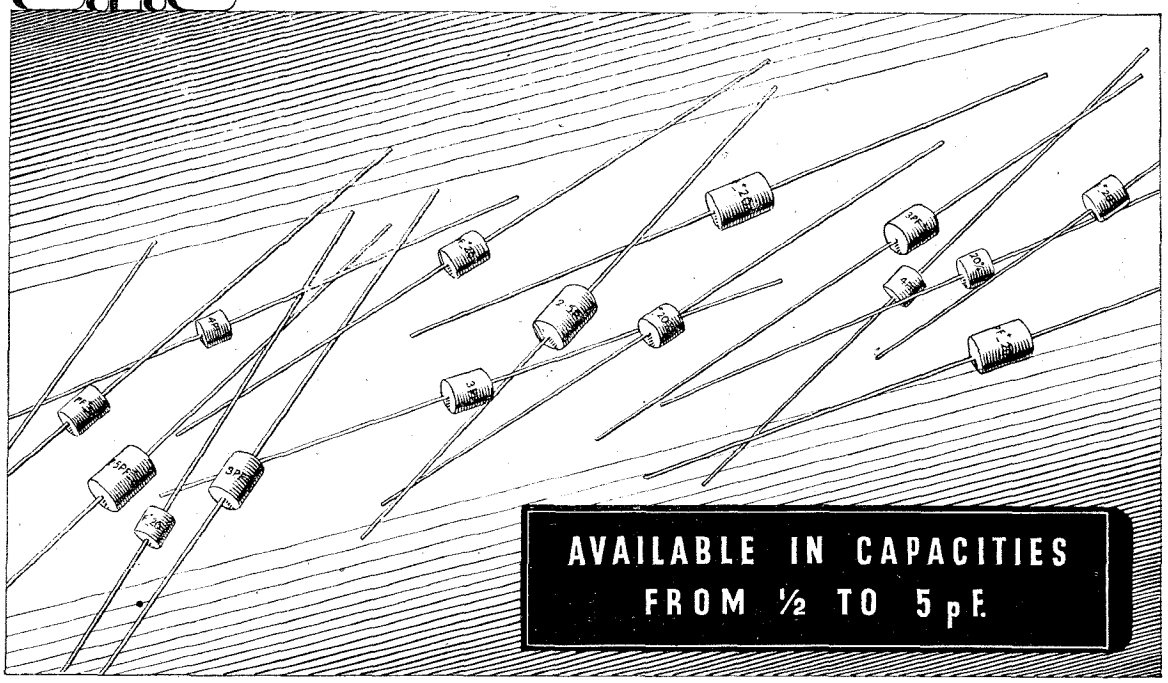
EITEL-McCULLOUGH, INC., SAN BRUNO, CALIFORNIA, U. S. A.
Export Agents: Frazar & Co., Ltd., 301 Clay St., San Francisco, California, U.S.A.


1 2 3 inches
FUSE
FUSE
FUSE
FUSE
BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX

G.P. 5900

U.I.C *Silvered Ceramic Condensers*

PEARL TYPE



Fixed Condensers with Ceramic Dielectric. The smallest condensers on the market. Mechanically and electrically stable.

Test Voltage -	1,500 Volts D.C.
Capacity - Tolerance	±20%
Finish - - -	Normal—Double lacquered.
	Tropical—Wax coated.
	Type approved.

Full details and advice gladly given.

UNITED INSULATOR CO. LTD.

12-20, LAYSTALL STREET, LONDON, E.C.1

'Phone: TERminus 7383. 'Grams: CALANEL, SMITH, LONDON.

CONTRACTORS TO G.P.O. AND GOVERNMENT DEPARTMENTS.
ON A.I.D. APPROVED LIST.

The Pioneers of Low-loss Ceramics

PROGRESS . . .

Never content to rest upon their present best . . . striving always to find new ways to improve what is already as perfect as human minds and hands can devise . . . Thus have Mazda maintained their reputation.

MAZDA

RADIO

VALVES

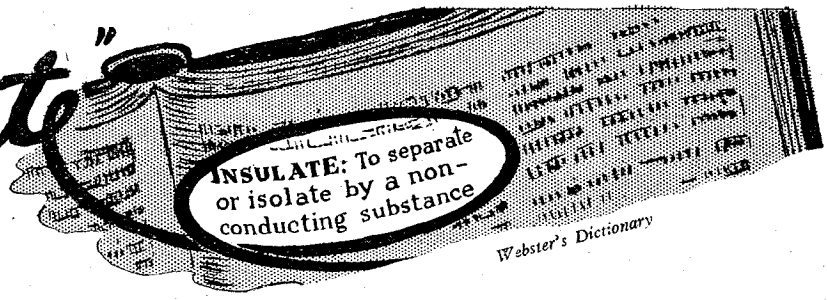
THE EDISON SWAN ELECTRIC CO. LTD

155 CHARING CROSS ROAD, LONDON, W.C.2

For full particulars write to Technical Sales Department.

RM.7

"to Insulate"



Practically all waxes are used to "separate or isolate," but the degree of insulation provided by the different types of waxes varies enormously.

There is obviously no higher degree of insulation required than that of electrical components and apparatus in intense electrical fields, especially in the extremes of conditions to which they are subjected to-day.

We specialise in the supply of

WAXES *for all*

purposes – under all conditions

Our technical advice is at your disposal.
If you have any problem of

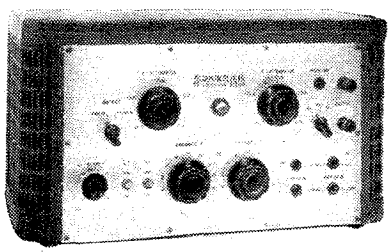
IMPREGNATING—DIPPING—FILLING

we, as consultants to the Industry, shall be glad to offer you a solution.

CLAUD CAMPBELL & CO. LTD.

4, LLOYDS AVENUE — LONDON — E.C. 3.

Telephone Nos. :—ROYAL 5403/4/5.



EQUIPMENT AVAILABLE for PRIORITY CONTRACTS

C.40. Mains- and battery-driven 30-watt amplifier—Twin channels, independently controlled, employing nine standard service valves—Four inputs—Output stage operated as Triodes or Tetrodes—Bass and treble controls—Variable output impedance—etc. (as illustrated).

C.30. 30-watt amplifier for 12-volt operation only—Inputs for microphone and gramophone—Standby switch—Tone control—etc.

M.30. As type C.30, but operated from 200/250-volt 40-100 c.p.s. mains.

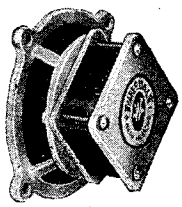
for AMPLIFIERS, TRANSFORMERS AND ALL P.A. EQUIPMENT

ACOUSTICAL

MANUFACTURING COMPANY LTD
HUNTINGDON 'TEL: 361

WHARFEDALE

MIDGET 3½-inch UNIT



ALCOMAX MAGNET

Flux Density 8,000 lines.

Speech Coil 15 ohms or 2/3 ohms. The first Wharfedale Unit using the new ALCOMAX magnet steel which gives extremely high flux density with small size. Designed for use as Microphone or Midget Speaker. Very sensitive.

Supplies are available for PRIORITY ORDERS ONLY

PRICE **28/6** (*list*)

WHARFEDALE WIRELESS WORKS

(SOLE PROPRIETOR: D. E. BRIGGS)

HUTCHINSON LANE • BRIGHOUSE • YORKS

'PHONE: BRIGHOUSE 50 'GRAMS: "WHARFDEL"

ADVERTISEMENT OF THE TELEGRAPH CONDENSER CO., LTD.

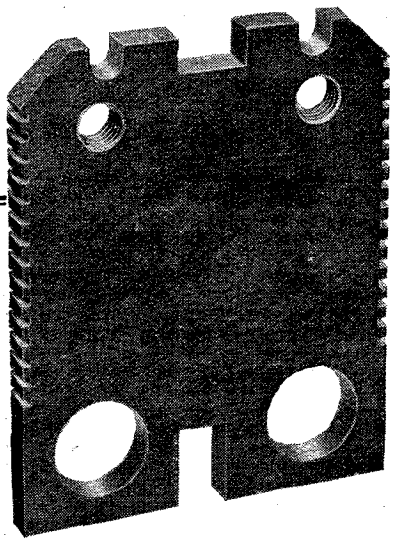
G.P. 5256

MYCALEX

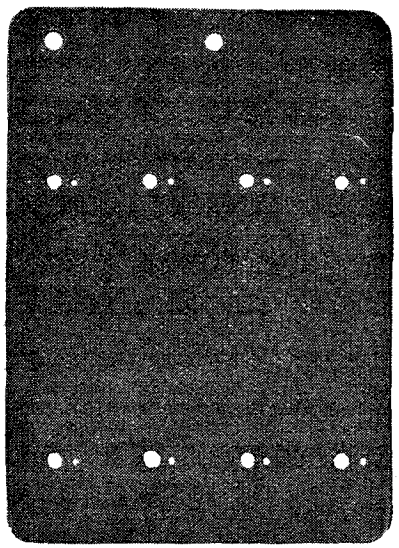
(REGD. TRADE MARK)

THE SUPREME INSULATOR

Readily machinable to fine limits and of a toughness allowing safe use of lighter sections than other insulating materials. MYCALEX is ideal for radio transmission or reception insulation, short and ultra-short wave insulation—in fact, for all high frequency work.



This example illustrates MYCALEX sheet, cut, milled, trepanned, tapped without fracture or crumbling and all edges sharp and true.



One-eighth inch MYCALEX sheet, precision drilled.

Our experience is at your service, on application to :—

MYCALEX LTD., CIRENCESTER, GLOS.

B.I.

RADIO MATERIALS

We have had a long experience in the manufacture of all kinds of Cables and Wires, Static Condensers, Insulators and Iron Work, Telephone Cords and Copper Earthing Rods, for Radio use.

U.K. Regd. Trade Mark.

BRITISH INSULATED CABLES LTD.

CABLE MAKERS AND ELECTRICAL ENGINEERS

Head Office:

PRESCOT, LANCS. Tel. No. PRESCOT 6571

THE POWER BEHIND-

The Perfect Portable Power Supply in service under arduous conditions in Transmitters, Receivers, Amplifiers, etc.

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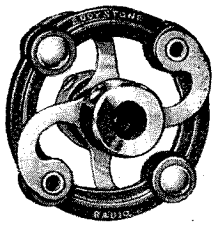
VIBRANT WORKS, WATFORD, HERTS.

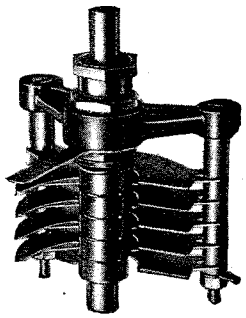
Greenwood

EDDYSTONE *Precision* COMPONENTS



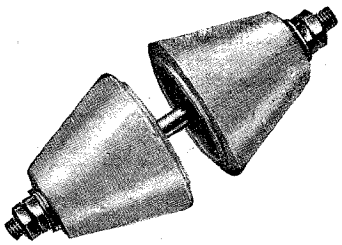
FLEXIBLE COUPLER

Cat. No. 1009. Flexible but free from backlash. Diameter 1½in. for ¼in. spindle. The insulation gap is sufficient for voltages in the region of 2,000, making it valuable for transmitting equipment.



MICRODENSERS

Cat. Nos. 1093/94 and 1129/30/31. Available for a wide range of capacities, Brass construction with all vanes soldered to give low series resistance at high frequency. Design ensures constantly maintained capacity.

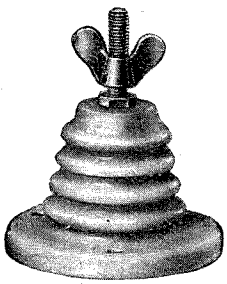


LEAD THROUGH INSULATORS

For carrying high frequency leads through metal chassis and screens with the least loss. Cones of glazed Frequentite flanged to self centre into metal at each side. Cat. No. 1018.

SHORT WAVE H.F. CHOKES

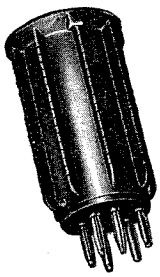
Several types available, including Cat. No. 1010. Resistance 20 ohms. Inductance 1.25 millihenrys. 5-180 metres. Windings are arranged to give minimum self capacity and small external field.



STAND-OFF INSULATORS

Cat. No. 916.

Ideal for mounting transmitting inductances, meters, spacing inside aerial feeders and for any insulating where high voltages are carried. Made in vitreous porcelain of special quality. Shaped to give very long leakage path and high mechanical strength.



6-PIN COIL FORMERS

Cat. Nos. 1002 and 1003. A "D.L.9" eight-ribbed moulding is used of 1⅛in. diam. giving 2⅛in. winding space. Particularly useful for the construction of efficient low-loss inductances for receivers and low-powered transmitters.

To obtain consistently good results on short-wave work, well-designed components are essential. Eddystone have specialised on precision components for H.F. and U.H.F. work and have developed a range second to none for efficiency. A wide selection is now obtainable from stock at Webb's Radio and further items are being rapidly added.

WEBB'S RADIO

The home of the Short-Wave Enthusiast

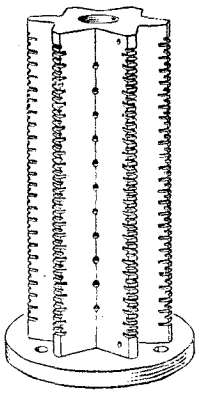
14 SOHO ST., LONDON, W 1 'Phone: GERrard 2089. *Hours of Business: 9 a.m. to 5 p.m. Sats. 9 a.m to 12 noon.*

RAYMART
CRAFT A CREED

HIGH FREQUENCY COIL FORMER

This latest addition to the Raymart range of Formers has a multitude of uses, in particular we would mention the making up of Aerial Coupling Units or Tapped Tank Coils.

The following general specification should be carefully noted :



PRICE
4/6
EACH.

1. The former is double grooved to allow for a double or coupling winding.
2. There are in all 46 winding grooves.
3. Four holes enable one to securely fix the starting and finishing of the turns of each winding.
4. Tappings can be taken at any suitable position, as there are 11 holes supplied for this purpose.
5. Baseboard or pillar mounting can be carried out by means of 3 fixing holes in the base.
6. Former measurements : Winding 1½ in. diam. Base 2 in. diam. Overall height 3½in.
7. The material used is RMX (new type). A high grade of loloss ceramic material which is suitable for operation on any frequency up to 56 m.c.

RAYMART KNOBS FOR SMALL COMPONENTS

By the addition of the small Knob illustrated, we have completed the excellent range of Raymart Knobs for use with our TXD and TXS series of Knobs and Dials.

This New Knob is 1½ in. in diameter, takes ¼ in. spindle and has grubscrew fixing. A finely finished black control knob.

9d. each.

RAYMART
CRAFT A CREED

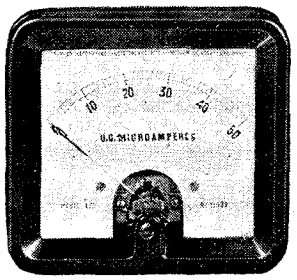
Enquiries invited from Government Departments, Manufacturers and Traders. All public enquiries should be accompanied by stamped addressed envelope.

Telephone : MIDLAND 3254.

48 HOLLOWAY HEAD, BIRMINGHAM, 1

TAYLOR-METER

We manufacture five types of moving-coil meters from 2″ to 5″ in scale length.



TAYLOR MODEL 425 MOVING-COIL METER

(Scale length 3½″)

The illustration shows our Model 425. This can be supplied in any range from 25 Microamperes full scale up to 100 Amperes D.C. and, as self-contained Voltmeters, up to 1,000 Volts. These can also be supplied as Rectifier type meters both as A.C. Ammeters and A.C. Voltmeters.

Taylor Model 425 *is available as follows :*

D.C. & A.C. MICROAMMETER
From 0-25 μA and upwards.

D.C. & A.C. MILLIAMMETER
All ranges.

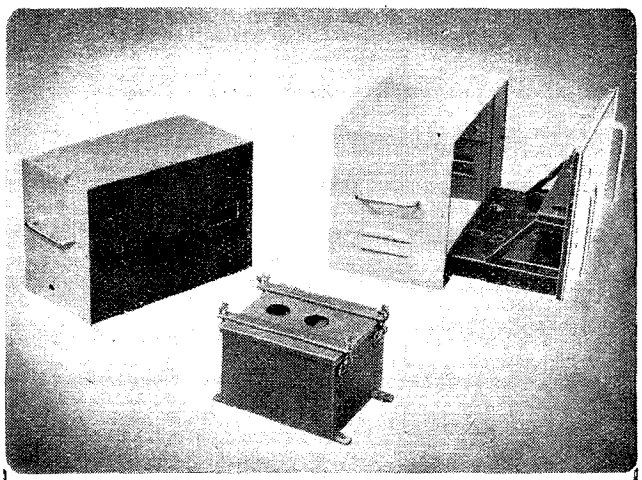
D C. AMMETER
All ranges up to 100 Amperes. Self-contained.

A.C. AMMETER
Self-contained up to 5 Amperes. Higher ranges can be supplied with Current Transformer.

D.C. & A.C. VOLTMETERS
Self-contained up to 1,000 volts. Normally supplied at 1,000 ohms per volt.

British made by
TAYLOR

For full details please write to :—
TAYLOR ELECTRICAL INSTRUMENTS LTD.
419-422, Montrose Avenue, Slough, Bucks.
Phone : Slough 21381.



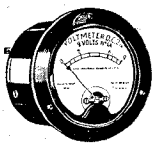
INSTRUMENT CASES

Our fully equipped modern factory produces all types of metal instrument cases, radio chassis, panels, brackets, boxes and other metal components. Complete amplifying equipments designed and manufactured for special requirements.

Enquiries to be addressed to our Head Office :—Alfred Imhof Ltd., 112-116, New Oxford Street London, W.C.1. *Museum 5944*

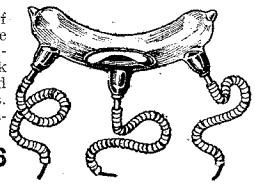
IMHOF'S

MOVING IRON D.C. VOLTMETERS



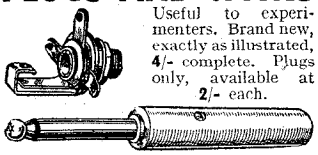
A good quality panel mounting meter with clear-reading 2½in. dial. Voltage measurement 0–9v. Fitted with terminals at back. Brand new. Price **20/-**

BRAND NEW MERCURY SWITCHES



These switches are of the best manufacture and not easily obtainable to-day. Quick make and break and will carry 5 amps. Many hundreds of useful applications. Small quantity to clear. Price **8/6**

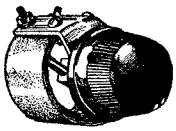
PLUGS AND JACKS



Useful to experimenters. Brand new, exactly as illustrated, **4/-** complete. Plugs only, available at **2/-** each.

VARIABLE RESISTANCES

HEAVY DUTY TYPE



Here is a well-made resistance of excellent quality which will carry about 10 watts and has a wiping contact. All brand new. Price **6/6**

★ *ONLY A FEW LEFT!* ★

BAIRD TELEVISION RECEIVERS

Model T.26. Brand New. Offered at the cost of parts only

See June advertisement for full details

- **SMALL TRICKLE CHARGERS,** Skeleton Type. Metal rectification. Input 200–220 v. A.C. Output 2 v. ½ amp. Reliable and Shockproof .....Price **17/6**
- **G.E.C. MOTORS,** 1/100th H.P., A.C. 225 v. 50 ~ **47/6**
- **SINGLE R.A.F. EARPHONES,** resistance 750 ohms D.C. approx., **4/-** each; ex-Govt. low-resistance single earphones, **2/6** each; microphone buttons, well-known make, **2/-** each.
- **MAINS TRANSFORMERS.** Originally made for Television Power Packs where accuracy and robustness are essential. Weight 12 lb. size 5¾in. × 4½in. overall. 350–0–350 v. 120 m.a. Tapped. 4 v. 2 a.; 4 v. 8 a.; 3 v. 3 a.; 20 v. 1 a. Diagram free. Post and packing 1/6 ..... **25/-**
- **HEAVY DUTY MAINS TRANSFORMER.** Input 240 v. A.C. One tapping at approx. 5,000 v. max. 3 m.a., and one for supplying filament of Mullard H.V.R. 2 (6.3 v. at .65 amp.). Shrouded in metal box. Car. fwd. **10/6**
  Also input 200–250 v. A.V., approx. 6,500 volts. Shrouded in metal box. Car. fwd. **20/-**
- **CELESTION 8in. P.M. SPEAKERS,** brand new, boxed, complete with universal transformer ..... Each **25/6**
- **B.I. CONDENSERS.** .1 × .1 mfd. 7,000 volts D.C. test, with porcelain insulators **30/-**

A new delivery of

BAIRD TELEVISION POWER PACK & AMPLIFIER CHASSIS

Includes heavy mains transformer 350-0-350, 120 m.a., with 4 tappings. High voltage transformer for supplying C.R. tube. Various condensers including 16 × 16 mfd. 550 v. working, 1-16 mfd. 450 v. working, 50 × 50 × 2 mfd. B.I. Electrolytics, etc. Pentode output transformer.; chokes; resistors; trimmers; bias electrolytics; mica and tubular condensers; short-wave coils, etc. Workmanship and components are of the highest quality. Valve diagram free. Carriage forward. Add 2/6 for packing. **£3.17.6**

PHILIPS SMOOTHING CHOKES

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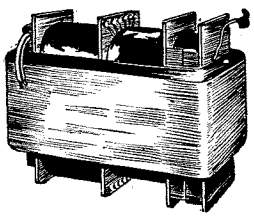

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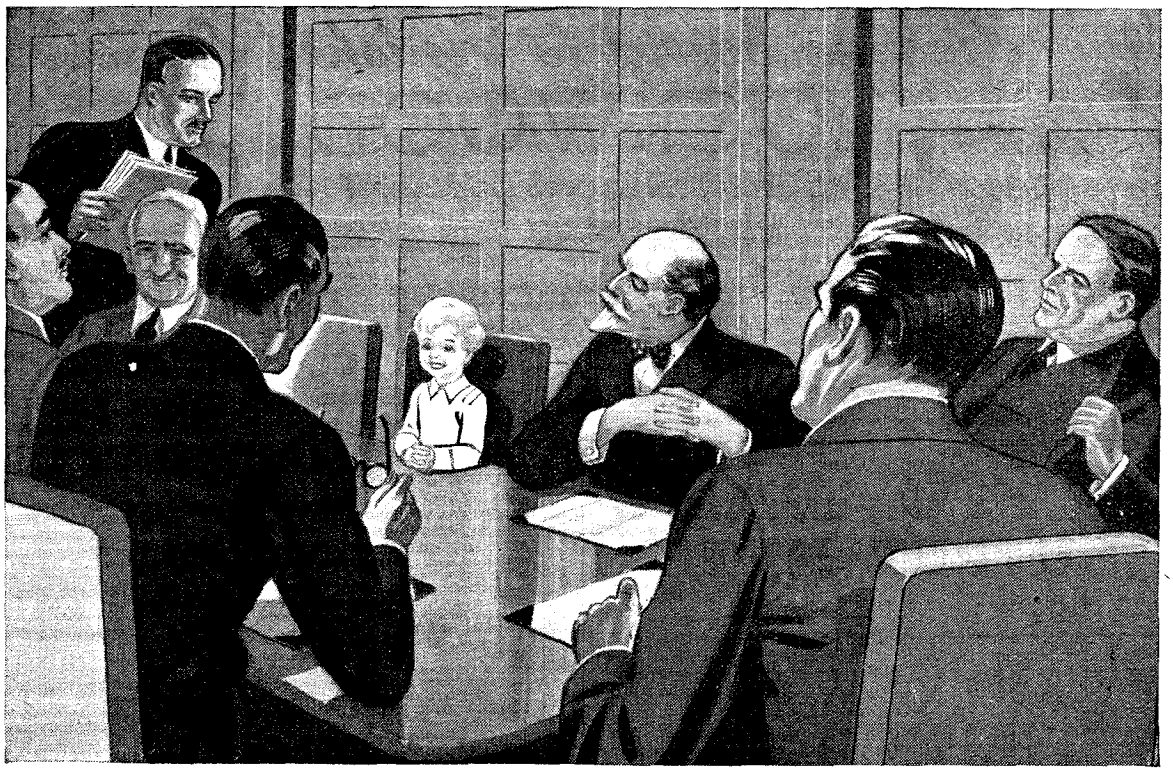

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P.6.

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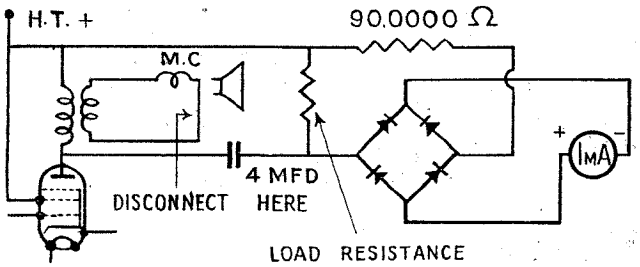

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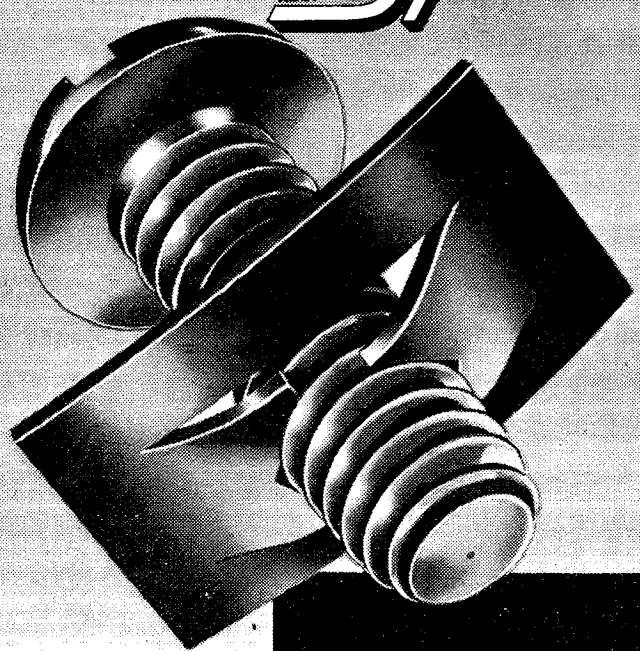

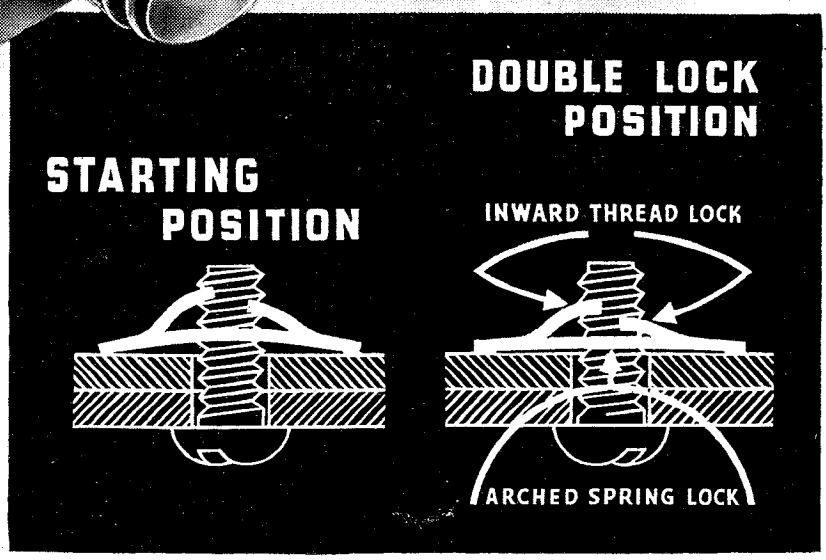

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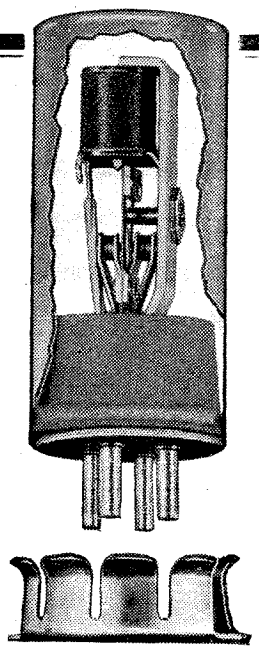

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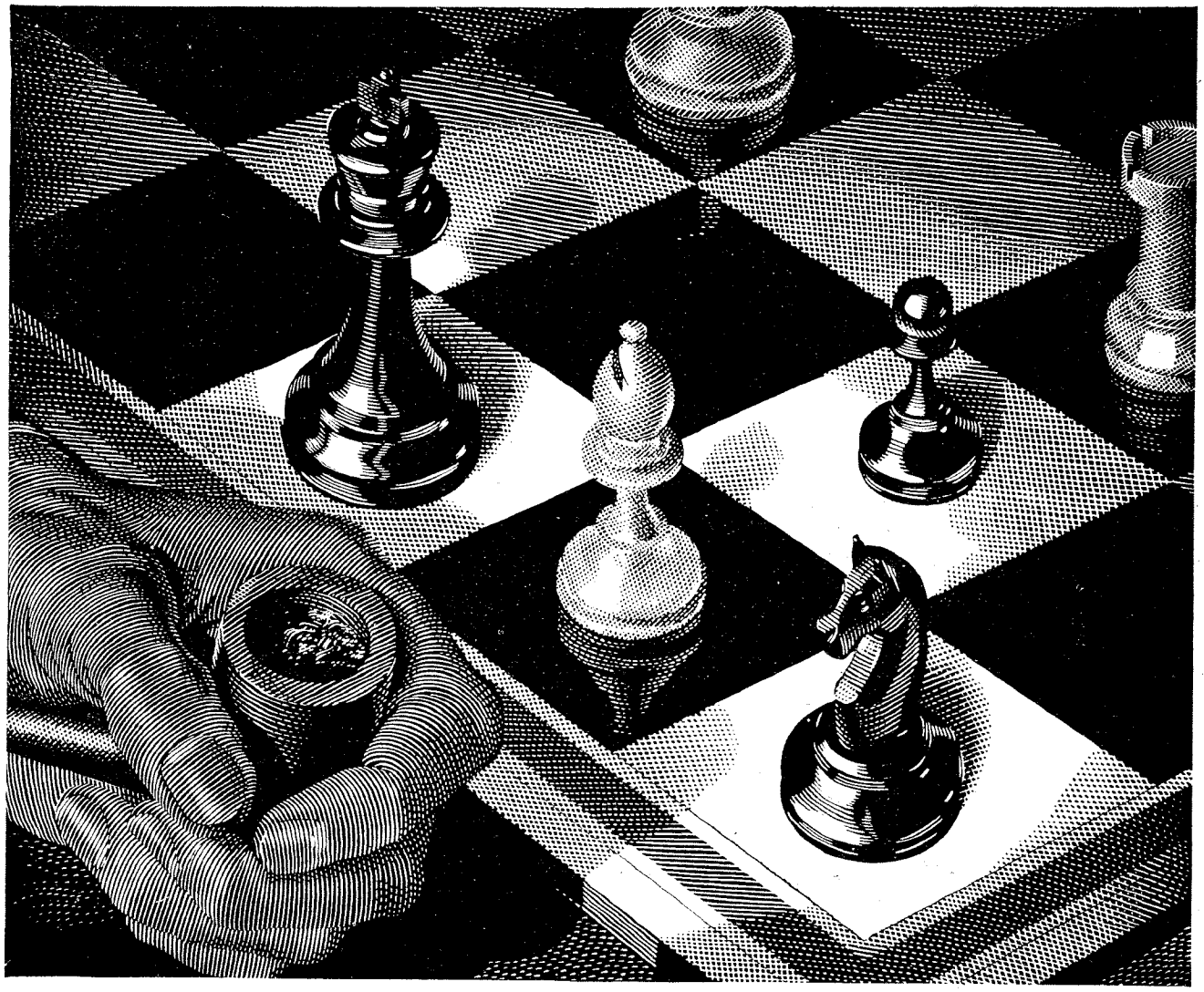

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Mass-produced Hearing Aids

Post-war Scope for the Wireless Industry

WIDESPREAD support has been given to the suggestion, made by a contributor to our May issue, that after the war the British wireless industry should turn its attention to the production of a type of hearing aid suitable for ninety per cent. of deaf persons to sell at four or five pounds through wireless dealers. It is a heartening thought to all concerned with the development of wireless that our technique—though, unfortunately, often misused—has contributed so much to the sum of human happiness and well-being. Here, it would seem, is an opportunity to make yet another worth-while and large-scale contribution by minimising the disabilities under which the deaf suffer.

Although there has so far been no serious opposition to our contributor's basic proposals, we think that a number of details call for consideration before a final working scheme can be drawn up. In the first place, definite medical support should be forthcoming; at least some measure of collaboration from the medical profession would seem to be essential. It is perhaps slightly disappointing that, so far, medical comment, or criticisms of the proposal, has been lacking. Unfortunately, in this matter of hearing aids the lack of support from the profession is regarded by the general public as being not entirely disinterested.

Overcoming Public Prejudices

Another point is that, before a really large market can be assured, something in the nature of a propaganda campaign must be launched in order to overcome the prejudice that certainly exists against hearing aids. Many sufferers from deafness are afraid to wear them; we have even heard of public authorities which discourage their use by employees, or at least regard it as a sign of disability. The wearing of a hearing aid should be regarded to be as natural as the wearing of spectacles, and certainly no more cause for shame or embarrassment.

A correspondent whose letter is printed in this issue questions the technical competence of the average wireless dealer to sell hearing aids. Though admitting the force of what he says, we should like to think that, even if his remarks apply to the pre-war position, they will no longer hold good in the post-war world. The seller of a highly technical product like a broadcast receiver should be technically competent—that is the justification for his existence. In any case, a hearing aid is much less complex than the average broadcast set.

Maintenance Problems

A similar line of argument may be used in rebutting the suggestion, made in our correspondence columns last month, that wireless service-men would be incapable of maintaining hearing aids. We should imagine that any service-man capable of handling an all-wave superhet, to say nothing of a television receiver, would regard the relatively much simpler hearing aid as child's play. It would be wasteful and unnecessarily expensive to create a "new branch" of servicing to look after hearing aids. Any competent man could quickly master their peculiarities.

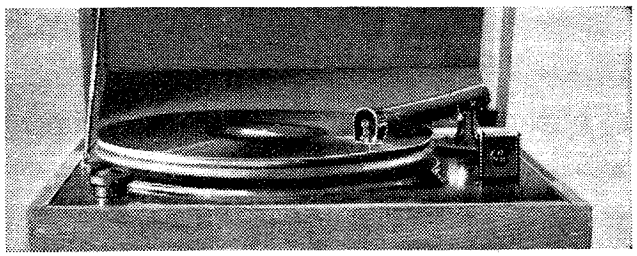
Finally, it should be stressed that the obviously desirable feature of cheapness of the mass-produced hearing aid should be attained through economy in production and distribution rather than by skimping the design. In particular, background noise, to which the deaf always take exception, should be kept down to the lowest possible level, and some form of automatic limiter should be included. The production of an alternative "bone-conduction" model should also be considered, as some types of deafness are best alleviated by that type of instrument.

Making a

MOVING-COIL PICK-UP

Design Considerations and Constructional Details

By
JOHN
BRIERLEY



The finished pick-up and tone arm. Note the packing to raise the record above the turntable.

THOSE of us who are keen on obtaining the best possible quality from recorded music realise that there is little we can do to hasten the adoption of systems of recording other than sound-on-disc. There is, however, ample scope for ingenuity in the design of pick-ups both from the point of view of improving quality of reproduction and reducing wear on the walls of the record groove.

As is well known, standard needles have been found unsuitable for reproducing satisfactorily the range of frequencies present on modern recordings, and it is rather unfortunate that many people have been led to believe that by the use of a smaller needle, the removal of the top resonance above and the bass resonance below the recorded range, a superior type of pick-up has automatically been produced. In fact, this is not necessarily the case. Assuming that the amplifier and loud speaker are of the highest quality, the outstanding defect in the reproduction of records is the characteristic buzz which accompanies and so detracts from the enjoyment of the desired sounds. If the moving parts of the pick-up are reduced in size, it often follows, other things being equal, that the *mechanical* buzz is to some extent reduced; but it does not follow that the proportion of buzz in the electrical output will be reduced.

Needle Wear

The experiments which the writer has made with various kinds of pick-ups and which have led to the construction of the one to be described, have shown that this phenomenon is the audible manifestation of many kinds of defects, some of which are very difficult to trace and cure. It has been suggested[1] that the predominating cause of buzz in pick-ups designed for use with standard-sized needles is the flat worn on the needle and the general inability of the point to follow the groove accurately with the maximum downward pressure considered advisable. It would therefore seem that a reduction in the mass and moment of inertia of the moving parts, resulting in less needle wear and better tracking, would lead to the trouble being mitigated; but this is true only if the initial supposition is correct and if the frequency range covered is kept identical, for the extended frequency range of pick-ups using miniature parts accentuates the buzz to an extent greater than the anticipated reduction. The writer's experience indicates that the importance of this source of buzz has been somewhat exaggerated and that other causes could, with advantage, be investigated and if possible eliminated.

That the length and nature of the needle and armature are such that in the majority of cases they contribute some of the unwanted vibrations is quite obvious, and it would seem to be very advantageous to reduce the inherent stiffness of the moving parts so far as is possible without bringing the top resonance too low or causing the high frequencies in general to become attenuated—the latter being more often than not the limiting factor in pick-ups of the type under discussion. No deterioration of the pick-up's performance in other respects need occur, particularly if the moment of inertia as well as the damping of the moving parts *for movements in the direction of the groove* are made large compared with those for the desired lateral movement.

Returning for a moment to buzz and distortion due to needle wear; as the high-frequency response is extended the useful life of a needle is very considerably reduced. To give an extreme example: using a pick-up with a top resonance above 15,000 c/s and with an average downward pressure of ½ oz., it was found that the point of an H.M.V. Silent Stylus needle became worn to an extent which very much increased the buzz output after 15 sides. Furthermore, if the 15 sides played were recent issues, the point was useless for playing older records with presumably a different groove shape, the quality being very bad and the scratch level very high. It is evident, too, that the downward pressure required increases very considerably as needle wear increases, so that for the best results with a steel needle an adjustable downward pressure with a range up to four times the average minimum value is required. It can hardly be emphasised too much that in order to minimise buzz and lengthen the useful life of a needle without causing any deterioration in quality, a low-pass filter cutting at 8,000 c/s and in some instances lower, should always be used.

Practical Design

Turning now to the practical design of a moving-coil pick-up, the first consideration is not only the needle pressure but also the maximum permissible weight of the pick-up head, consisting for the most part of the magnet and the tone arm. A practical example will serve to show the significance of this. If a pick-up head and tone arm weighing about 8 oz. are counterbalanced to give a downward pressure of ½ oz., it will be found that on only a slightly warped record the variation of the downward pressure, due to the inertia of the head and arm, is so great that the needle point will be thrown out of the groove on the outside of the record. It will be obvious, therefore, that in a design requiring only a small downward pressure, a light tone arm, the use of as small a magnet as possible, and a spring to take up excessive weight in place of counterbalancing are essential.

By the use of new alloys the efficiency of permanent magnets is constantly being increased, and one the writer has found suitable is the "Eclipse Pocket Magnet"; owing to the war, the makers can no longer sup-

[1] "Pick-up Design," *Wireless World*, Oct. 27th, 1938.

ply these magnets, but the stocks of small tool dealers are not yet exhausted and it is still possible to obtain them.

The dimensions given are based on the "Eclipse" magnet, but the reader will no doubt be able to make adjustments in other cases.

Pole Pieces

The pole pieces of mild steel can conveniently be formed from the keeper supplied with the magnet. Having been cut into two by a hacksaw, each part should be filed until it is $\frac{1}{3}$in. wide, i.e., the width of the magnet (as supplied the keeper is slightly more than this). Each pole piece should then be $\frac{7}{16}$in. long, $\frac{3}{16}$in. thick and $\frac{1}{3}$in. in width. At one end of each pole piece, parallel with the $\frac{1}{3}$in. sides, a groove 0.1in. wide and 0.05in. deep should be filed; at right angles to this a groove 0.25in. wide should be filed. Each pole piece now has, as it were, four claws, and when these are put together the gap so formed should be 0.1in. between faces. The construction of the pole pieces is completed by chamfering the sides so that the surface of the opposed faces is

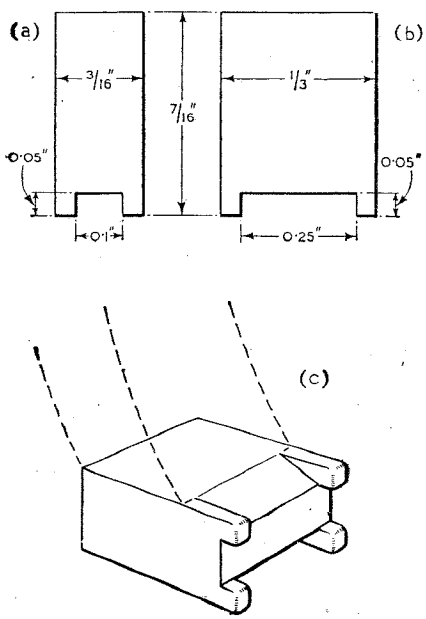


Fig. 1. Dimensions and perspective sketch of one of the pole-pieces.

0.1in. instead of $\frac{3}{16}$in. across. (Fig. 1(c)). The claws can also be reduced by careful rounding of the corners so that only a small area of the original surface is left for contact with the opposite pole piece. This will help to reduce the magnetic short-circuiting of the gap which, in practice, is not serious, and is accepted on account of the simplification of construction.

Next comes the construction of the end plates which, in the final assembly, bind the magnet, pole pieces and coil into position. The construction of these should be quite clear from the diagram (Fig. 2). They may be made from any light, rigid and non-magnetic material such as aluminium

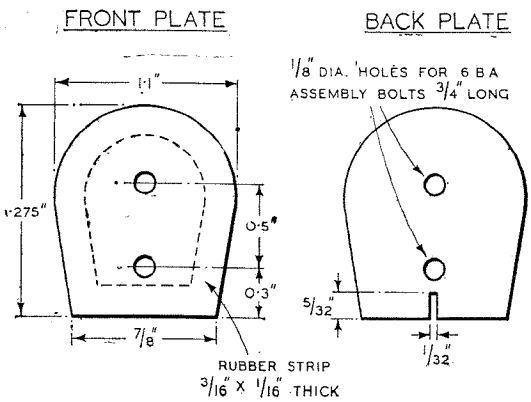


Fig. 2. End plates for clamping magnet, pole-pieces and moving coil. Any light non-magnetic material may be used, of a thickness to give the requisite rigidity.

or bakelite, etc. It will be noticed that a strip of rubber not more than $\frac{3}{16}$in. wide and $\frac{1}{16}$in. thick is secured round the edge of the front plate and a slit about $\frac{1}{32}$in. wide is cut from the middle of the bottom edge of the back plate for a distance of $\frac{5}{32}$in.

It is felt that at this stage the reader will have a good idea of the general arrangement, and attention can now be given to practical coil designs. It should be emphasised that although the method of construction and the dimensions of the coil and pole pieces must necessarily be given separately, the two are quite inseparable and it will be appreciated that the exact dimensions of the pole pieces are entirely dependent on the coil design, so that any substantial alteration to the coil will require the appropriate modification of the pole pieces to be made. The method of mounting the coil, however, is such that slight inaccuracies are largely absorbed and the final assembly is neither critical nor difficult.

The outstanding problems for the design of a coil using a steel needle were, on what should the coil be wound, could the material be not only light but sufficiently resilient to grip a steel needle without any special clamping device and at the same time be capable of transmitting energy to the coil without appreciable loss or frequency discrimination, would it be tough enough to withstand the strain of use and constant needle changing without collapsing and finally, of course, would it be easily obtainable? It is obvious that if a substance could be found to satisfy all these requirements, then the coil former and the needle-holding device could be combined into one, thus reducing the mass to an absolute minimum and simplifying construction.

The writer has experimented with a large number of materials, including various plastic materials, and one that has been found most satisfactory is celluloid (Xylonite). Fortunately this is already likely to exist in the majority of households, namely, the translucent, slightly transparent, and usually, though by no means invariably, colourless material from which a very large number of toothbrush handles are made.

The dimensions of the coil system are shown in Fig. 3, but it should be noted that the dimensions given are for the former itself, and allowance has been made for the space taken by the winding. Before referring to the actual construction, mention should, perhaps, be made to the shape of the former. The completed coil is made circular in cross-section and is tapered towards the ends. This is done so that the restoring force is kept low while at the same time permitting considerable damping of the coil for movements in other than the desired direction. This point will become more obvious when the mounting of the coil is dealt with.

The construction of the coil former and the winding of the coil are quite simple. A piece of the selected material is cut $\frac{1}{3}$in. × $\frac{1}{5}$in. × $\frac{1}{5}$in. An H.M.V. Silent Stylus needle is gripped in a small hand vice and the material is then pierced as if using a bradawl, taking care that the hole bored is at

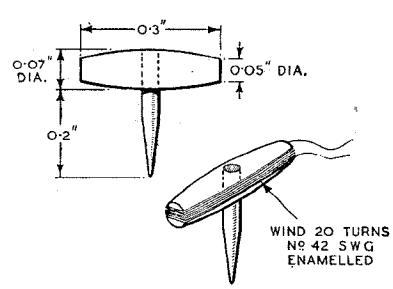


Fig. 3. Final dimensions of celluloid coil former and cut-down H.M.V. Silent Stylus needle.

right angles to the length. The tapered part of the point should pass right through so that a parallel hole is left in the block.

The material can now be conveniently filed down to the correct shape and dimensions, and during this process it is advisable to keep the needle in position, since it is easier to see that the correct disposition of the former round the needle is being maintained. The final dimensions should be very slightly less than ⅓in. long, a diameter of 0.07in. in the middle (this has been found to be the minimum that can be relied on to support the needle) tapering to 0.05in. diameter at the ends.

For the winding the writer used No. 42 SWG aluminium wire because a quantity of this was available, but enamelled copper wire will give practically the same results. With regard to the gauge, this is not in the least critical, and, though No. 42 is probably the easiest to handle for coils of the size under consideration, higher or lower gauges may be used and the turns increased or diminished accordingly to keep the weight of the coil approximately the same.

The method of winding is as follows: With the former impaled on a needle, grip the needle in a vice in a convenient position. Spread a quantity of Durofix round the former, then wind on the requisite number of turns, taking care that each and every turn is "drowned" in the Durofix. Press the coil so that unnecessary adhesive is squeezed out, and remove surplus. The beginning and end of the winding are, of course, brought out at the same end, and should be

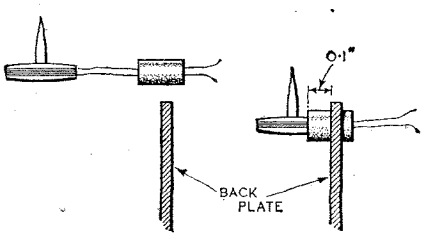


Fig. 4. Illustrating the method of mounting the coil in the back plate.

left for the moment about 2in. or 3in. long. The weight of the coil without the needle should be in the region of 75 milligrams.

Mounting the Coil

The needle used with this coil should be cut to between 0.25in. and 0.275in. long, and the end should be touched up with a file so that no sharp edges cut and enlarge the holder.

For mounting the coil in the gap, an inch or two of 1½ mm. inside diameter rubber tubing, with walls about 1 mm. thick, should be obtained. A $\frac{3}{16}$in. length should be slipped over the "lead-out" wires of the coil. The ends of the tube should then be gripped with two pairs of small pliers, when the tube can then be easily pulled into the slit in the back plate and arranged so that about 0.1in. protrudes on the coil side (Fig. 4). The ends of the wires should then be gently pulled until the end of the coil "noses" into the rubber tube. A 0.1in. length of tubing is slipped over the other end of the coil, and the whole is ready for the assembly of the pole pieces, magnet and front plate.

With regard to tone arms, the writer feels rather hesitant in making any specific suggestions. The chief difficulty in adapting a tone arm of any other pick-up is that, in general, they are almost certain to be far too heavy; and, as has been pointed out earlier in this article, it is essential to use one which is as light as possible. In the photograph is shown an arm which was made from aluminium cut from an old amplifier chassis. It was bent to shape, and stayed at three points along the bottom edges, the effective mass being about ⅜ oz. Other tone arms for pick-ups of similar design have been made from an old aluminium hot-water bottle which had been overlooked in the search for salvage, and also other odds and ends.

Only on one occasion has any trouble from tone-arm resonances been experienced, and that was during the testing of an experimental composition arm which turned out to be too flimsy—three small humps (about 2½ db.) appeared in the frequency characteristic of the model using a steel needle, in the danger zone of 200 c/s to 600 c/s. It would seem, therefore, that with tone arms of moderately good design the response of both models can be relied on to be an exact replica of the recording characteristic.

With regard to the downward pressure, it should be variable between ½ oz. and 2 oz., or fixed at a compromise of about ¾ oz. It should also be mentioned that the turntable should be padded to lift the record about ¼in., otherwise the attraction of the magnet to the steel turntable appreciably increases the downward pressure.

The head should be set for a trailing angle in the region of 2 to 3 degrees.

With a 1.7-ohm coil coupled to a 150 : 1 ratio transformer, the average output across the secondary was about 1/8 volt.

One final point which should not be overlooked, the lead-out wires from the coil should be soldered to the flex lead at not more than ½in. from the coil, and this flex should be firmly clamped by a tag under the lower of the two assembly bolts.

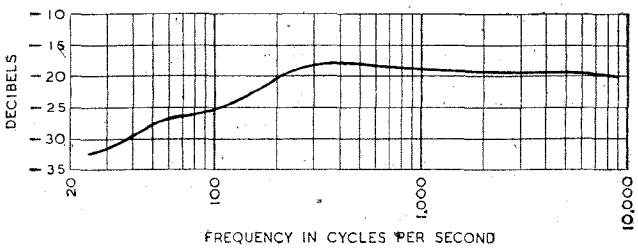


Fig. 5. Frequency characteristic of pick-up using H.M.V. Silent Stylus needle (cut to 0.25"), at secondary of 150 : 1 coupling transformer. Test record H.M.V. OB 4037. Zero db. corresponds to 1-volt peak.

In conclusion, it may be stated that the primary object of this article is to show that the construction of a pick-up which is robust, simple to make, and capable of giving the best possible performance, is compatible with the prevailing shortage of supplies. The finished pick-up, in conjunction with the coupling transformer, makes a suitable substitute for the Telefunken pick-up specified in Mr. Scroggie's "Electric Gramophone," described in the May 11th and July 27th, 1939, issues of *Wireless World*.

Meeting a Need

ONE result of the war is that those who used to consult foreign technical journals at libraries, or subscribe to them direct, are, in many cases, now no longer able to do so. The Abstracts and References section of our sister journal, *Wireless Engineer*, is often the only remaining guide to them as to what is being published abroad.

As a result of requests, and in order to help remedy this state of affairs, translations of foreign papers of special interest, and occasionally reprints from journals printed in English that are not readily available in this country, will be published in *Wireless Engineer*. The first of these, on superheterodyne tracting charts, which is reprinted from the *A.W.A. Technical Review*, appears in the June issue.

Published on the first of each month, *Wireless Engineer* is obtainable to order through newsagents or direct from our Publishers at Dorset House, Stamford Street, London, S.E.1, at 2s. 8d. (including postage).

R-F INSTABILITY

Data on the Effect of Stray Wiring Capacities

By
S. W. AMOS, B.Sc. (Hons.)

MOST radio engineers are quite proficient at estimating the capacity of variable air-dielectric condensers: it is simply a question of gauging the area of the plates, their number and the separation between neighbouring plates. It is a more difficult matter to estimate the capacity between two parallel rods or wires; how difficult is shown by a test carried out by the author, in which three experienced radio engineers were asked to judge the capacity between two parallel brass rods, each $\frac{1}{4}$in. in diameter and 15in. long, separated by $\frac{1}{4}$in. (i.e. $\frac{1}{2}$in. between their centres). None of the estimates exceeded $3\mu\mu$F, and yet the capacity, as determined approximately by a capacity bridge, was something under $10\mu\mu$F! This result will be confirmed later.

In each case the engineers underestimated the capacity. The reason is probably that, in any estimates of capacities, one instinctively—if unconsciously—applies the formula for a parallel plate condenser, which, in one practical form for an air condenser is written:—

$$C = 0.0884 \frac{nA}{t} \mu\mu F,$$

where A = area of one of the parallel plates (expressed in any units),
t = distance between neighbouring plates (expressed in the same units),
and n = number of layers of air dielectric in the condenser;

whereas the capacity between two parallel rods is given by a formula of an entirely different type, namely:

$$C = \frac{0.2778\, l}{\text{Cosh}^{-1}\frac{D}{d}} \mu\mu F.$$

Here l = length of the rods in centimetres,
D = distance between the centres of the rods (in any units),
and d = diameter of the rods (in the same units).

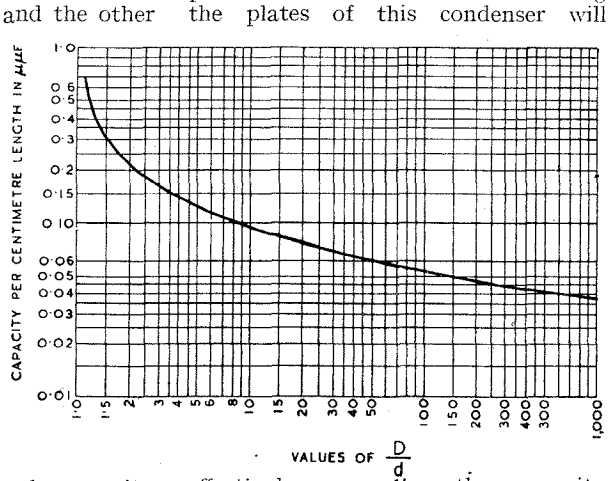
As tables of hyperbolic cosines are not always to hand, it is perhaps preferable to write this in the more convenient form:

$$C = \frac{0.1206\, l}{\log_{10}\left\{\frac{D}{d} + \sqrt{\frac{D^2}{d^2} - 1}\right\}} \mu\mu F.$$

The capacity per centimetre length of rod for various values of $\frac{D}{d}$ has been plotted in the accompanying graph. As an example of the use of this, let $d = \frac{1}{4}$ and $D = \frac{1}{2}$, as in the case of the brass rods mentioned earlier. $\frac{D}{d}$ is thus 2, and reference to the curve shows the capacity per centimetre length to be $0.21\mu\mu$F. The total capacity is thus $15 \times 2.54 \times 0.21 = 8.04\mu\mu$F, which, allowing for the difficulty in assessing such low capacities on the bridge, confirms the measured value quoted above.

A Practical Case

Turning now to more practical considerations, suppose a receiver is connected up with 20-SWG wire (diameter 0.036in.) and that two particular lengths of wire run parallel, 3.6in. apart, for a distance of $\frac{1}{4}$in. Imagine that these two wires are connected, one in the grid and the other in the anode circuit of the same RF amplifier, and let us consider whether the capacity between them is sufficient to prejudice unduly the performance of the amplifier.



Curve showing the capacity per centimetre length between two parallel rods of diameter d, with centres separated by a distance D.

The curve tells us that the capacity between these wires is $0.033\mu\mu$F. Now a formula quoted* for the maximum amplification, A, obtainable without instability from a single RF valve with similar tuned circuits in grid and anode circuits is:

$$A = \frac{2}{C_{ag} R_d \omega}$$

where C_{ag} = anode-grid capacity of valve,
R_d = dynamic resistance of each tuned circuit (i.e. resistance at the resonant frequency, f),
$\omega = 2\pi f$.

In a typical RF stage, C_{ag} might be $0.004\mu\mu$F, R, 100,000 ohms and ω, 6.28×10^6 c/s (corresponding to the medium frequency of 1,000 kc/s or 300 metres). Substituting these values in the above formula we get the maximum stable amplification as about 780. One would be very lucky, of course, to achieve this even very approximately in a practical amplifier—as we shall see.

The effect of the parallel wires is to place a condenser of $0.033\mu\mu$F in parallel with C_{ag}, thus effectively increasing its value by 9 times and so, from the above formula, reducing the maximum amplification obtainable without instability to 87, i.e., to one-ninth of the maximum obtainable at that frequency with that particular valve and tuned circuits.

An earthed conductor or screen placed between the two wires forming the plates of this condenser will effectively neutralise the capacity between them, and it is thus clear how essential it is to employ very thorough screening between anode and grid circuits if high gain with stability is wanted. Manufacturers generally achieve a gain of some 200 times in a single stage of IF amplification, and, even though this is at a lower frequency than we were considering above (making stable amplification easier to obtain), it will be clear that effective screening has to be employed.

* *Wireless World*, November 25th, 1937, p. 528.

INSTRUMENTS: *Test and Measuring Gear and Its Uses*

By W. H. CAZALY

IV.—Testers and Bridges for Inductance and Capacitance

IT should be recalled that inductance and capacitance are *properties* of electrical circuits. Inductance can be deliberately conferred on a conductor to a given amount by making it of a calculated shape and size. Capacitance can similarly be brought into being by special arrangements of conductors in space. From this it follows that fundamentally it is possible to calculate, from the shape, dimensions and positions in space of conductors and a knowledge of the electrical properties of the medium surrounding them, the amount of inductance or capacitance present. There are, in fact, many formulæ enabling these purely physical and mechanical factors to be estimated with some precision.

However, it is not often convenient and easy to estimate the amount of inductance or capacitance present from physical data. It is commonly easier to observe the effects produced in electrical circuits and deduce from the measurements of these effects how much inductance or capacitance is present.

Perhaps the prime effect of both inductance and capacitance is that of reactance to AC. This corresponds in AC circuits to resistance in DC circuits (up to a point, of course) and can be shown in a very easy way simply by including the inductance or capacitance in a circuit carrying AC and observing what difference to the current flowing is made by the presence or absence of the inductance or capacitance. The circuit is basically that shown in Fig. 1 (*a*). The similarity between this circuit and that of a circuit suitable for measuring resistance with DC will be apparent if it is imagined that the alternator V in (*a*) is replaced by a battery, and Z by a known variable resistance. The procedure would be to adjust the variable resistance with terminals 1 and 2 short-circuited until a certain value of current, measured by the ammeter, were passed. Then the short-circuit connection between 1 and 2 would be removed, leaving the unknown resistance, corresponding to *Zx*, in circuit. The addition of this resistance to the circuit would cause a fall in the current passed, depending on the value of the unknown resistance, which could be readily calculated by simple Ohm's Law formulæ, from a knowledge of the value of the variable resistance, and of the voltage of the battery.

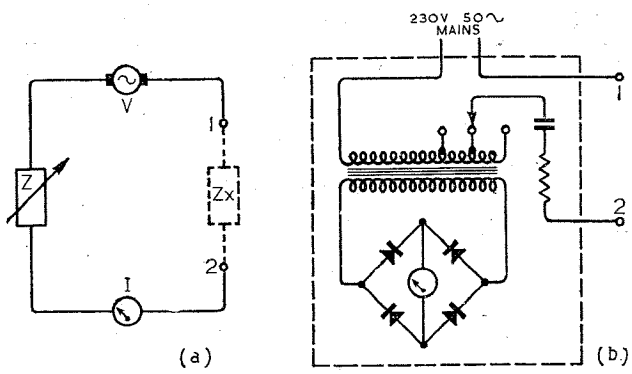


Fig. 1. (a) Resistance or impedance measuring circuit in which the addition of the unknown element Zx makes a change in the current flowing in the circuit. (b) Simplified form of circuit with provision for reactance measurement. A series resistance is included in the primary circuit to prevent resonance, and the capacity is to stop DC.

This is, of course, the sort of circuit that is widely used in the resistance-measuring ranges of ordinary multi-range meters using an internal battery and adjustable resistance, the scale being marked in terms of the unknown resistance connected across the test terminals.

The same thing can be done using AC mains as the source of EMF, as shown in simplified form in Fig. 1 (*b*) and arranging the impedance of the primary circuit of the current transformer in the rectifier type AC ammeter commonly used so that with the test terminals 1 and 2 short-circuited, the pointer of the meter reads at full scale deflection. When the short-circuit across the terminals is replaced by the unknown impedance, the current is not so great, and the pointer falls to a degree marked in terms of the unknown impedance.

Snags exist in this apparently very simple arrangement. The word "impedance," rather than either inductance or capacitance, has been purposely used, because, especially in the case of an inductance such as a choke or similar AF winding, the component or circuit being tested very often contains appreciable resistance as well as reactance or may consist of mixed inductive and capacitative reactance as well as resistance, the whole forming an impedance. Now, the effect of a mixed impedance in a circuit is very different from pure

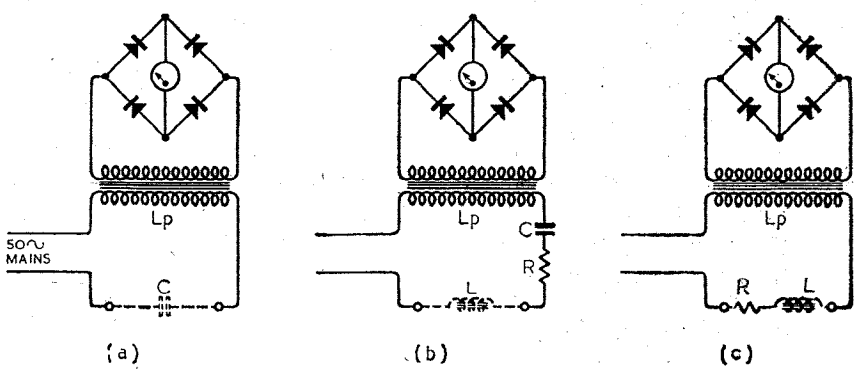


Fig. 2. (a) A possible source of error in the circuit of Fig. 1 is that Lp and the test condenser C may form a series resonant circuit at the AC mains frequency. (b) A similar danger exists in this circuit if inductance is connected across the test terminals. (c) Resistance in the inductance windings may, if it forms a considerable proportion of the total impedance, invalidate the calibration of the inductance measurements in an instrument designed to make them.

reactance. In Fig. 2 is shown what may actually be encountered in practice. Fig. 2 (*a*) shows an unknown condenser to be measured placed across the test terminals of a multi-range meter provided with a scale calibrated in microfarads for such measurements using AC mains. The makers of commercial instruments of this kind take good care to avoid it, but it is not impossible that home-made instruments may be so constructed that the inductance of the current transformer primary L*p* in combination with the capacitance of the unknown test condenser C form a series LC circuit tuned to the fundamental or a low harmonic of the mains supply. This unfortunate coincidence will manifest itself in the destruction of the meter or the blowing of the mains fuses, since such a circuit offers extremely low impedance to AC of the resonant frequency.

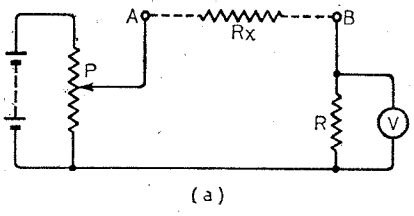
In commercial instruments, therefore, it is usual to include so much resistance in the primary circuit, together with sufficient fixed capacitance, as to render it substantially non-resonant to mains frequencies no matter what unknown capacitance is connected across the test terminals. Fig. 2 (*b*) shows what may exist if the component being tested happens to be a choke connected in a circuit that is intended only to measure capacitance. Although the addition of any amount of capacitance might not render the circuit resonant to mains frequencies, the addition of inductance may—with disastrous results. L*p* + L may form with C a series resonant circuit, the whole of the power being carried effectively by R and burning it out. C and R may be capacitance and resistance purposely included inside the meter on the capacitance measuring range to avoid resonance under proper conditions. Needless to say, any approach to resonant conditions completely invalidates the calibration of the meter scale in any case.

DC Resistance Errors

A third possibility is shown in Fig. 2 (*c*), where the choke being tested has such high resistance windings that its DC resistance R forms a considerable part of the impedance it offers. This is quite often the case. The impedance of L having a DC resistance R_L is given by $\sqrt{\omega L^2 + R_L^2}$. If R_L is considerable, as happens with thin-wire windings in small size chokes, the impedance in ohms is much more than the reactance offered by the inductance of the choke alone, and the meter scale calibration offers very unreliable indications in terms of inductance alone.

These simple methods of measuring inductance and capacitance by applications of "Ohm's Law for AC circuits" have, evidently, serious limitations. The difficulty and expense of providing adequate AC supplies at the power and voltage levels required, and the comparatively high audio frequencies, that would be needed to give reliable indications with unknown inductances and capacitances of small values, lead to most of the "universal" types of multi-range meter employing AC mains at 50 c/s and over 200 volts as the supply. This low frequency severely curtails the limits of the inductance and capacitance values that can be reliably measured on them. Usually they are only fit to measure inductance between about 0.5 to 50 H, and even then they must be of fairly high "Q" (i.e., have low DC resistance windings). The equivalent capacitance range is from about 0.1 μF to some 10 μF. Electrolytic condensers cannot be tested on them, nor do they indicate the power factors of condensers and coils. However, for general AF work, they are very useful, since low values of inductance and capacity are not often involved and the accuracy of measurement need not be very high.

A rather more serious limitation lies in the difficulty, in the case of inductances with iron or alloy cores, of observing the changes in effective inductance with the passage of various amounts of DC through the windings. This is often of great importance. Unless it is to be used in a circuit carrying pure AC of limited peak value, knowledge of the open-circuit inductance of a choke or transformer winding is liable to be very misleading. For example, the inductance of the primary of an output transformer may be, when measured with no DC flowing through the windings, as high as 40 henrys. But with the anode current of the output valve passing through it, say 30 mA, it may fall to 7 or 8 henrys, and any calculations about output and fidelity made on the basis of a 40-henry inductance as the valve load be rendered meaningless. Again, a small "midget" intervalve transformer with a "high-mu" alloy core may possess an astonishingly high open-circuit inductance—which practically vanishes when even a few mA are passed through the windings. For this reason, good manufacturers of reliable AF inductances are usually careful to state, or even give curves showing variations, with DC flowing, of the inductances of their products under given conditions involving the passage of DC through the windings.



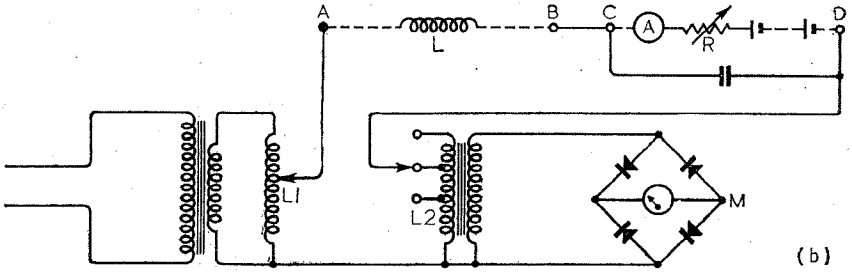


Fig. 3. (a) Illustrating the basic principle of a "constant voltage or current" resistance measuring instrument. (b) The same principle is employed in the AC version for measuring inductance, and the accessory terminals C–D enable known current to be passed through the windings and the effect on inductance to be estimated.

One ingenious form of circuit for measuring inductance under such circumstances, that has been commercialised in convenient forms, consists of a slight variation of the application of "Ohm's Law for AC circuits." The basic form of it is given in Fig. 3 (*b*), but a consideration of an equivalent DC circuit employing resistance, shown in Fig. 3 (*a*), may make its operation clear. If, in Fig. 3 (*a*), the test terminals A and B are short-circuited, the slider of the potential divider may be adjusted to a position near the negative end so that just sufficient voltage is developed across R to bring the voltmeter V to full scale deflection. Now the short circuit across A and B is removed and the unknown resistance R*x* is connected. The reading on the voltmeter V obviously will fall. It can be brought back to full scale deflection again by moving the slider of the potential divider P farther up towards the positive end. In such an instrument it is not necessary that the voltmeter scale should be calibrated in terms of the unknown resistance—all it has to do is to indicate full-scale or

Instruments—
some set deflection—but the position of the potential divider slider, as shown by a dial, may be so calibrated. By suitable choice of battery voltage and by varying the values of R, a wide range of unknown resistance may be easily and fairly accurately measured.

Similar principles are employed in the AC version shown in Fig. 3 (*b*). Here, the "battery" is replaced by power from the mains, transformed down to a voltage suitable to be applied across a continuously variable AC potential divider L1 consisting essentially of a single-layer winding on a heavy circular iron core. Over this single layer moves a sliding contact arm. The resistance R of the DC circuit is represented by the inductance L2 of the primary of the meter (rectifier type) current transformer, the voltage across which is indicated by the meter M. If both A-B and C-D terminals are short-circuited, the slider of L1 can be adjusted to make the meter M read to some set mark on its dial. Now the short-circuit is removed from A-B and the unknown inductance

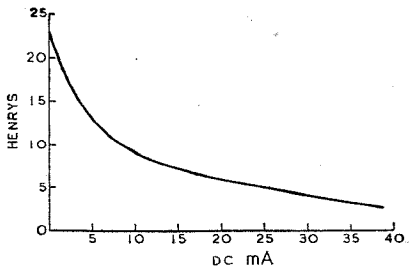


Fig. 4. A typical curve showing variations in inductance with magnetic polarisation of the iron core by DC.

is connected. The reading on the meter will fall, and can be brought back to the set mark again by adjusting the slider of L1. The position of L1 as indicated on the dial is calibrated in terms of the unknown inductance in henrys. By selecting taps on the primary of the meter transformer L2 (which corresponds to varying R in the DC circuit) a wide range of inductance can be measured. Moreover, if the short-circuit across the terminals C-D is replaced by a battery, ammeter and regulating resistance, a known DC can be passed through the unknown inductance windings, and the resultant changes in its effective reactance and thus its inductance can be ascertained by adjusting the slider of L1 to obtain set reading on the meter with each spot value of DC passed. A curve, of the kind shown for example in Fig. 4, may thus be readily obtained.

Even with this type of instrument, the effect of high resistance in the unknown inductance windings seriously affects the validity of the calibration of the slider dial. At low AF, however, it is possible, by taking a simple DC measurement of the resistance of the windings, to calculate approximately its probable effect in practical apparatus. It will be noted that the DC also passes through the other windings of the instrument in series with the

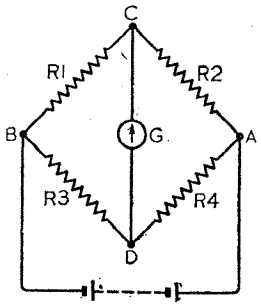


Fig. 5. The classic Wheatstone bridge circuit, still employed in laboratories and workshops for accurate measurement of resistance.

test inductance, and may affect accuracy if excessive. Once again, a warning is necessary against connecting condensers across the terminals of such instruments, in case an unlucky chance brings about resonant conditions.

All the preceding methods of measuring inductance and capacitance suffer from two limitations. They are difficult to carry out on small inductances and capacitances, and they do not reveal the power factors of condensers or the "Q" of coils. To deal with such measurements it is usual to make use of AC bridges. These are merely variations of the classic Wheatstone bridge principle with adaptations to suit the type of measurement being made. For the purpose of reference, the Wheatstone bridge principle is shown in resistive form in Fig. 5. When $\frac{R1}{R2} = \frac{R3}{R4}$, the potential of C in relation to either A or B is the same as that of D; hence no PD exists between C and D, and no current flows through the galvanometer G, which registers zero. This is the condition of "balance." If it is assumed, for illustration of the practical use of this circuit, that R1 is an unknown resistance connected for test purposes, and that R3 = R4 or $\frac{R3}{R4} = 1$, then balance can be obtained when $\frac{R1}{R2} = 1$, or R1 = R2. R2 may consist of a standard resistance box so that when it is made equal to R1 (as shown by the galvanometer giving zero reading), it reveals the resistance of R1. If R3 is made, say, 10 times as great as R4, then R1, in balanced conditions, is 10 times the resistance shown on the standard resistance box. Thus a very wide range of resistance can be very accurately measured.

Bridge Operation

When the bridge is energised by AC, it becomes possible to substitute capacitances for R1 and R2, as shown in Fig. 6 (*a*). Again the basic equation holds good, $\frac{C1}{C2} = \frac{R1}{R2}$ when no PD exists between C and D, as is shown, in this circuit, by either an AC meter or a valve voltmeter. The frequency and voltage of the AC energising source do not matter apart from their influence on the choice of a balance indicator. If a bridge of this type is energised by 50 c/s mains, it is not too easy to hear in a pair of headphones (unless they have quite exceptionally good low-frequency response) when balance is obtained. It is more usual to employ some simple form of valve voltmeter, which is more sensitive than a rectifier type AC meter for this work. On the other hand, if a 1,000 c/s oscillator is used, the note is very easily heard, and as good headphones of high resistance (inductance, really) are amongst the most sensitive forms of indicator obtainable, they are quite suitable.

Since $\frac{C1}{C2}$ equals merely the ratio of R1 to R2, a linear potential divider may be substituted for these two

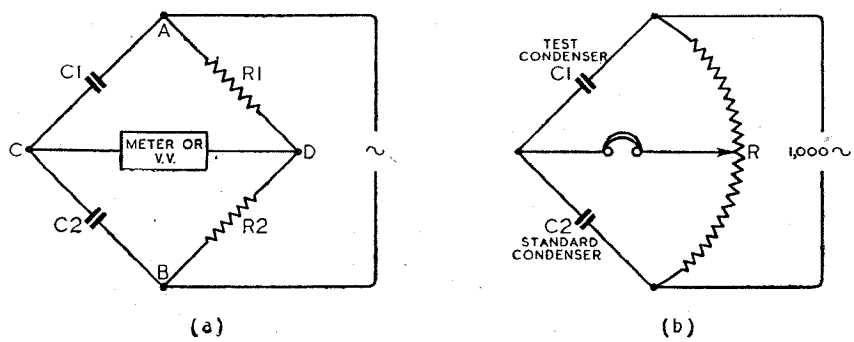


Fig. 6. When pure capacitance is substituted for resistance in the Wheatstone bridge circuit, the basic equations still hold good. In practice, C2 is a condenser of very small or negligible power factor and accurately known capacitance.

resistances, as in Fig. 6 (*b*), and balance obtained by moving the slider over R until the silent point is found. The actual resistances of the two parts of the potential divider on either side of the slider need not be known if it is a linear component—i.e., the resistance is constant per unit length—so that the physical position of the slider when at the point of balance is sufficient to indicate the ratio of C1 to C2; hence if C2 is a standard condenser of known capacitance, the actual value of C1 can be ascertained from the position of the slider and the dial thus calibrated directly in terms of the test capacitance. These forms of capacitance measuring bridge are quite satisfactory at audio frequencies and for the measurement of capacitances as low as 0.0005 μF. With a little common sense they are quite easily constructed in a workshop, and some practical circuits are given in Fig. 7. It should be obvious that elementary precautions should be taken against excessive stray capacitance arising from long and badly disposed wiring and its proximity to metal casing. Insulation is also of importance.

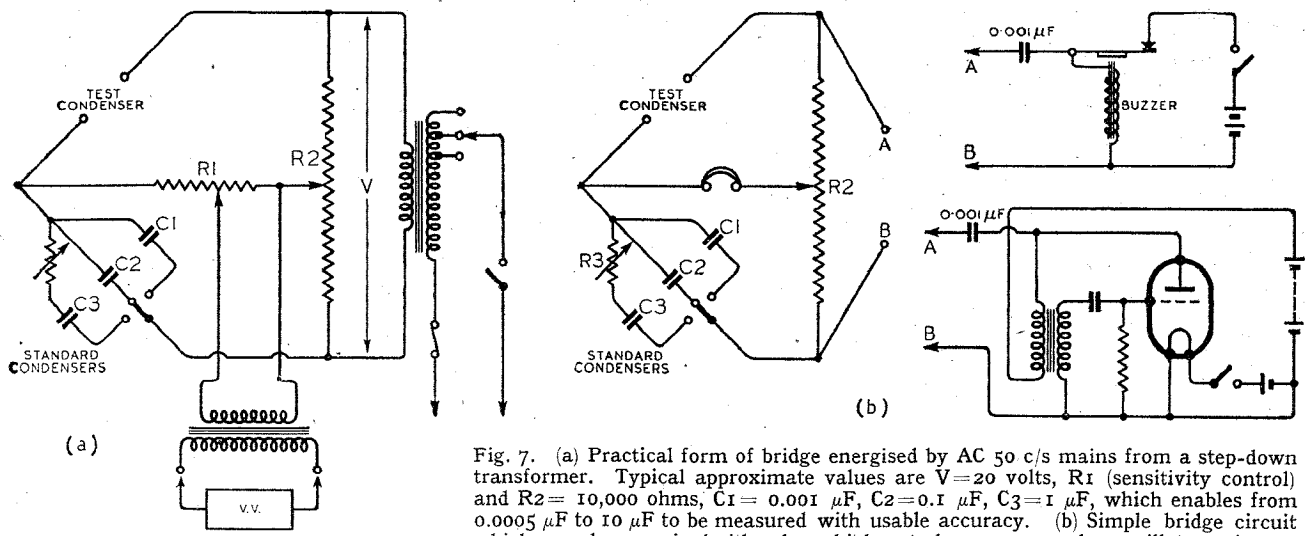


Fig. 7. (a) Practical form of bridge energised by AC 50 c/s mains from a step-down transformer. Typical approximate values are V=20 volts, R1 (sensitivity control) and R2= 10,000 ohms, C1= 0.001 μF, C2=0.1 μF, C3=1 μF, which enables from 0.0005 μF to 10 μF to be measured with usable accuracy. (b) Simple bridge circuit which may be energised either by a high-note buzzer or a valve oscillator using an intervalve transformer. R2 and C1, C2, C3 are of the same values as in (a). R3 may be about 1,000 ohms, and adjustment of it may be found necessary to obtain sharp balance when testing large condensers of poor power factor.

The Resistance Factor

The measurement of inductance by bridge methods is not so easy owing to the inevitable presence of a DC conducting path through the wire and its resistance. This will be dealt with later, but this factor of resistance perhaps existing in addition to reactance crops up also in the measurement of capacitance, especially with large condensers and with small condensers used in RF circuits. It will be noted that in the practical circuits given in Fig. 7, variable resistance is included in series with the largest values of standard condenser. This resistance is intended to simulate the effect, in the arm containing the standard low-loss condenser, of resistance or losses connected with the test condenser. It is not included with the smaller standard condensers, because "power factor" is very seldom of great consequence when measuring these comparatively large values of capacitance that are to be used in AF circuits—unless the condenser being measured has a defect, such as a leak, when this is tested for more directly by plain DC resistance measurement methods.

In some commercial bridge instruments for measuring capacitance, the variable resistance is actually calibrated, not in terms of the resistance, but in terms of the power factor of the condenser under test. If the test condenser has a "bad power factor," the effect is, in a simple bridge of the type in Fig. 6 (*a*) and (*b*), to make the balance point indeterminate, so that complete silence is not obtained in the headphones or zero reading in the indicating meter. It is as if the test condenser had a resistance in series with it, which would alter the phase relationship between the current through it and the voltage across it from the exact 90° that would occur if it were a pure capacitance. (A similar effect would occur if there were capacitance across one of the resistances in the other arm of the bridge; hence the importance of reducing the value of stray parallel capacitance to a minimum.)

The subjects both of inductance measurement, and of small capacitance measurement, especially at RF, and by methods other than bridge, will be dealt with in the next article in this series.

Salvage

IT would seem that many people have an exaggerated idea of the legal importance of various documents, whether for use as evidence in the courts or for other purposes. As a result, many documents are retained for an unnecessarily long period, and the repulping mills are robbed of valuable waste paper. The Waste Paper Recovery Association, 154, Fleet Street, London, E.C.4, has recently issued a leaflet, written by two leading chartered accountants, which gives advice on the length of time for which documents of various types should be retained. Copies can be obtained by anyone responsible for the storage of papers.

Although the wireless industry is fortunate in being not greatly dependent on rubber as a raw material, it must be remembered that the general position with regard to the supply of this commodity will soon become acute. Among the materials containing rubber that are urgently required for salvage is ebonite. Its use for wireless apparatus has fallen off of late, but considerable stocks probably still exist, sometimes in the form of panels of disused receivers.

Wireless World

Brains Trust

Problem No. 2

WHAT are the possibilities of transmitting electric power by wireless? Has it ever been tried? (*Solution on page* 172.)

UNBIASED

By

FREE GRID

Fiat Lux

I CERTAINLY seem to have rung the bell by my note in the May issue concerning the deplorable slackness nowadays in omitting the aspirate from words like Burmah and anhode. I have been assailed from all sides as, apart from the frontal attack by "Diallist" and the flanking movement in the correspondence columns by Mr. D. A. Bell, I have been subjected to long-range artillery fire by lesser lights who know not the Isis or the Cam. It would seem that our educational level has fallen to an even lower level than I had thought, but one can hardly wonder at it when people like "Diallist" appear on their own confession to have spent a large portion of their university career in sharpshooting with a rook rifle.

It is very evident that my assailants are totally ignorant of the original Cadmean alphabet and have learned nothing but the "Cockney" perversion of the old Ionian language, which is commonly known as Attic Greek; an excellent name for it, for, like "Cockney" English, one would expect it to be only known and used by the less fortunate members of the community whose lack of means compelled them to dwell in attics and garrets. "Diallist" and his fellow assailants—and in particular Mr. Bell with his categorical statement that the Greeks had no letter to represent H—do not seem to know that in the second millenium B.C. when Greek *was* Greek, before the Samians and other barbarians with their linguistic corruptions had begun to seep into the land, the letter H existed in its full glory, and not as an emasculated aspirate, and the totally un-Hellenic letter Eta did *not* exist.

But even in Homer's time the work of corruption had commenced, and by the time that Professor Joad's friend Plato was born, had eaten into the very core of the language, so much so that Plato in his Cratylo was led to complain bitterly about it thus:

και γαρ H *και* ʽ *ἐχρωμεθα ἀλλα* ʼE *και* H *το παλλαιον.*

It remains vividly in my memory, as in my youth I once had to write it out 10^3 times for the very offence which my detractors are committing, namely, forgetting it. Unfortunately, it is quite impossible for me to ask "Diallist" and Mr. Bell to go to their bookshelves to confirm my words for, being the good patriotic citizens which I feel sure they are, all their lexicons and other classical literature will, like my own, have long ago been pulped.

With regard to the word "radio," this is the present tense of a Latin verb, and if "Diallist" wants to use "Rhadio" on the grounds that Latin owes its origin to Greek, he should be consistent and go back a step further to the mother tongue of the Greek language. I would give him the correct word here and now, but Semitic characters do not lend themselves too readily to exact transliteration, and unfortunately the Editor tells me that the printers long ago sacrificed all their Hebrew type to the nation's needs in the way of scrap metal.

As for "Cathode," which Mr. Bell alleges to be cacophonous, it is no more so than the word catapult, and the mention of catapults brings me to another strange statement by "Diallist" to the effect that the Greek word *kata* implies a return home rather than a departure. Surely the word catapult itself, which is, of course, derived from Greek, should disprove this.

Literally, of course, *kata* means "down from," and I think I can see just why "down" and "home" are synonymous to "Diallist." Much as I regret to do it I must, in order to clear my own good name, wash some of "Diallist's" dirty linen in public. The two words are synonymous to him simply because he suffered the fate of being "sent down," or, in other words, sent home for going one better than his fellow undergraduates who used to adorn the spires and pinnacles of their *Alma mater* with certain domestic utensils, as I mentioned in the May issue of this journal. The thing got so bad that the authorities of "Diallist's" college engaged an old soldier whose duty it was to "traverse" the pinnacles of the college chapel with a machine gun at dawn every morning in order to avoid giving offence to the townsfolk.

"Diallist," who, if he learned nothing else at the university, certainly *did* learn the psychology of the soldier in the O.T.C., with the result that at dawn one morning the old warrior found that each of the domestic utensils was swathed in a Union Jack. True to military tradition, he refused to fire on the flag, and a man had to be hastily flown over from Germany especially for the purpose, with the natural outcome that the College authorities, who had to foot the bill, decided that their financial future demanded drastic action. *Sic transit Diallistus.*

Incidentally, I may mention as an anti-climax that a learned divine has written to me in all humility and Latin to suggest that the original coiner of the words cathode and anode probably did not take them from the word *hodos,* meaning "a road," but from the word *odos,* meaning "a threshold," and hence "a starting or finishing point," which certainly seems a more likely derivation.

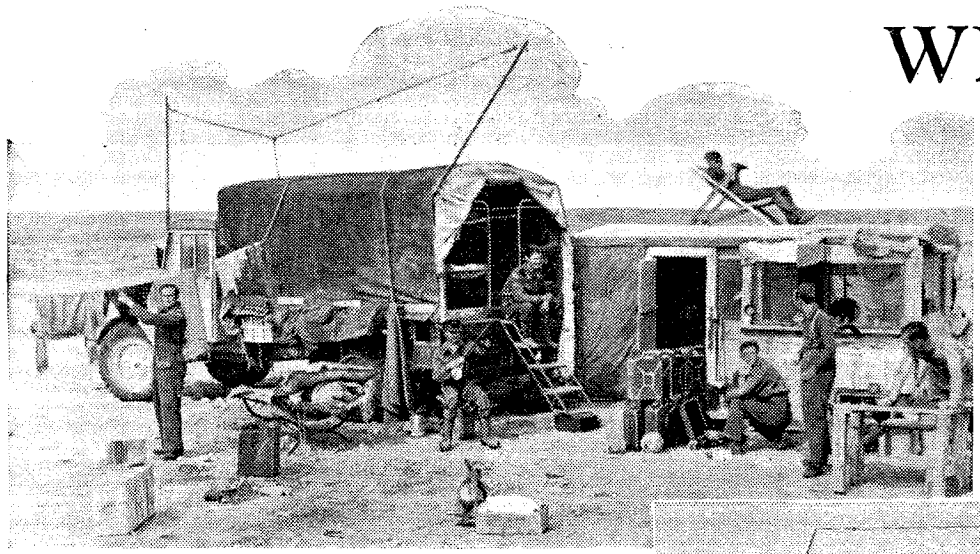
What War Means

WE are all engaged in such a stern fight for democracy nowadays that nothing else matters, and none of us can spare the time to bother about any side issues, as I told the electric light inspector the other day when he attempted to divert my attention from the war effort by talking about an unpaid bill. Even democracy can be overdone, however, as I was reminded when, happening to glance through the pages of *Wireless World,* I noticed that some advertisers attempt to remind readers that bus number so-and-so passes their door, or words to that effect. Surely these coarse reminders of the existence of a rather vulgar method of transport tends to lower the whole tone of the journal. *Wireless World* readers are, after all, essentially car owners enough, though some of them own cars which certainly look as though their value was rather less than that of a bus fare.

I spoke to the Editor about it, and he, at once, I am glad to say, hastened to reassure me by pointing out that these statements in advertisements are only being allowed to appear as a wartime measure when every patriotic citizen has long ago laid up his car without waiting for the withdrawal of the basic ration to do it automatically for him. Even *Wireless World* readers are, he explained, travelling by bus and tube nowadays, and mingling freely with quite ordinary people, while he himself intends one day to "make a gesture" by taking a bus ride; after the Press has been duly notified, of course.

WIRELESS UNITS in LIBYA

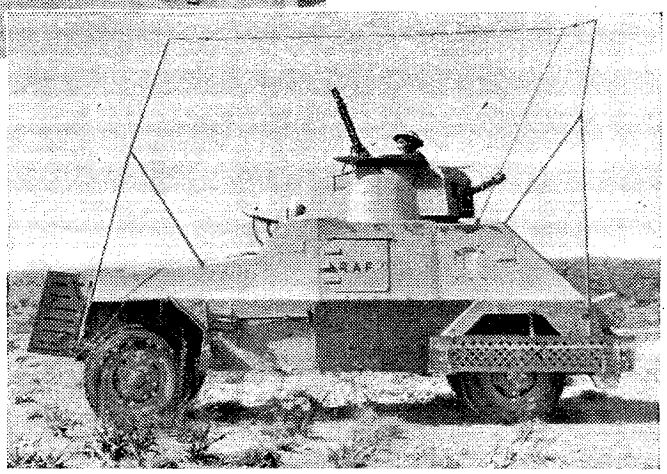
R.A.F. and Army Co-operation

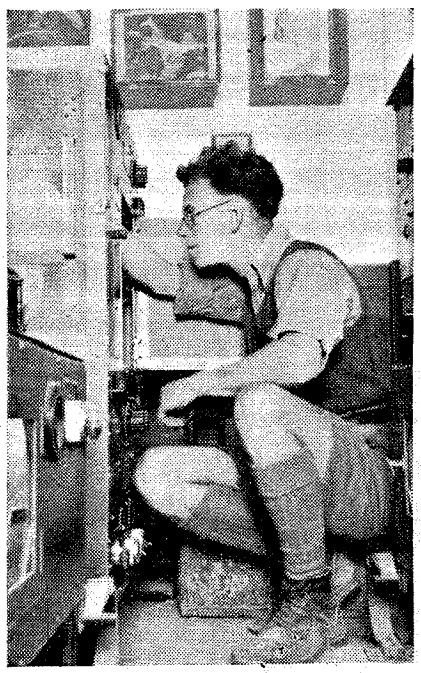


BECAUSE of the vast tract of country over which the Libyan campaign has been conducted, the use of wireless communications has been of the utmost importance and its applications to desert warfare are many.

One such application is the use of Wireless Observation Units, manned by combined R.A.F. and Army personnel, which were employed with great success in the previous campaign.

These units, which are known in the Services as "Wous," are posted in advance of the main body of our Forces, and it is their task to observe enemy planes and movements of troops and report their observations by radio to the base. Although details of the apparatus with which the observation unit is equipped are not available, it can be stated that it is compact and self-contained, and is fitted in the lorry (shown in the top picture), in which four of the crew have their sleeping quarters.





One of the "Wous" is shown in the top picture. The observer can be seen on the roof of the hut. A link in the important chain of wireless communication in desert warfare is the wireless-equipped armoured car (right) used by R.A.F. close support units

Another of the wireless units in use in the Middle East is a mobile W/T station, which is equipped with recording apparatus.

When first used in France the observation units were then manned chiefly by R.A.F. Auxiliary Wireless Reservists. At that time they were scantily equipped, but now they are a well-established and efficient branch of the Services, which is doing an important, though unobtrusive, job in Libya.

A mechanic adjusting apparatus in the transmitting and recording van of the mobile W/T station of the same type as that being erected on the right.

CATHODE FOLLOWER AGAIN

Simple Calculations of Output Impedance and Voltage Gain

By E. A. HANNEY,
M.Eng., Ph.D., A.M.I.E.E.

A DESCRIPTION of the cathode follower has been given in the columns of this journal.* This able account should be referred to in connection with these notes.

The article referred to includes an approximate expression for the low output impedance which characterises this circuit. An accurate expression for the output impedance can be obtained quite simply as follows.

The impedance of a circuit which supplies a load can be found by replacing the load by a source of voltage, evaluating the current which is established, and finding the ratio between voltage and current. Whilst the method is applied here to a cathode follower, it is a valuable tool in the case of other feed-back circuit calculations. It applies not only to simple circuits, including generators (provided the circuits are "linear," i.e., voltage and current proportional), but also to an amplifying stage.

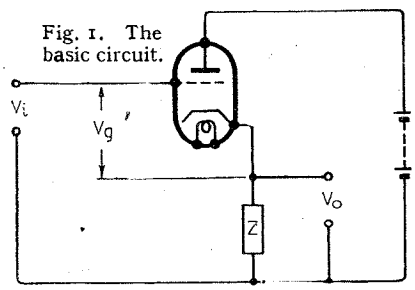


Fig. 1. The basic circuit.

Naturally the original generating action, if any, must be stopped; thus a battery circuit must have the battery voltages balanced out, and an alternator would have its field circuit opened. In the case of an amplifier, it is only necessary to join the input terminals, and replace the load by a voltage source.

Fig. 1 shows the basic circuit of a cathode follower, the cathode impedance of which is Z when its output is not in use. The load (a succeeding stage) is connected across Z. The grid voltage V_g with respect to cathode is, in general, $V_i - V_0$. Fig. 2 shows the equivalent circuit with a source of voltage V connected across the output terminals, and with the input terminals joined. In this case the grid voltage V_g becomes $V_i - V = -V$, since $V_i = 0$. If the voltage of the source is increasing, in the direction shown, and the cathode is imagined to be the fixed point of the circuit, the grid becomes more positive, and a voltage μV appears in the anode circuit in the direction indicated. Hence the currents I_a and I_z are added to give the source current I.

The voltage effective in establishing I_a is $(V + \mu V)$, and thus $I_a = V(1 + \mu)/R_a$. Also $I_z = V/Z$. Hence $I = I_a + I_z = V(1/Z + 1/R_a + \mu/R_a)$. The required output impedance, which may be less than Z, is thus

$$Z_0 = V/I = \frac{1}{\frac{1}{Z} + \frac{1}{R_a} + \frac{\mu}{R_a}}$$

This result is well known, but may be further simplified. The mutual conductance g_m is equal to μ/R_a. Also $1/R_a$ may be written g_a, the anode conductance; and $1/Z$ is the cathode admittance, call it Y. Hence the output impedance may be written simply as $\frac{1}{Y + g_a + g_m}$. It will be seen that this form indicates clearly the effect of each factor on the result.

As an example, consider a circuit in which g_m is 0.003 (amperes per volt). R_a is 10,000 ohms, and thus g_a is 0.0001. Z is a resistance of 1,000 ohms and thus Y is 0.001. Then Z_0 is $\frac{1}{0.003 + 0.0001 + 0.001} = \frac{1}{0.0041} = 244$ ohms. Even if Z is increased to 10,000 ohms, the value of Z_0 is only raised to 312 ohms.

It should be added that the accuracy of this expression is not affected by the existence of the grid-cathode capacitance, unless (as at U-H-F) the impedance of this capacitance is down to a figure comparable with that of Z. In such a case, the argument above gives a result in which an admittance, corresponding to this capacitance, is added to the denominator of the expression. Unless Z contains an inductance, the value of Z_0 will be still lower.

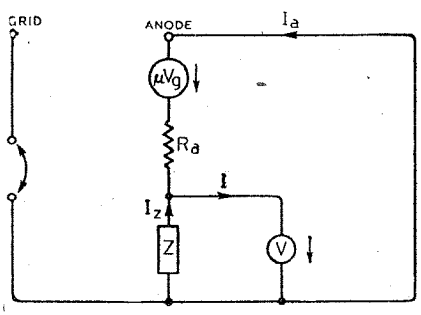


Fig 2. Equivalent circuit of cathode follower with a source of voltage connected across the output terminals.

In Fig. 1, if the value of Z is now considered to include the effect of the load impedance across the output terminals, and if the input impedance is recognised as being so high as to have negligible effect, we have the conditions of Fig. 3.

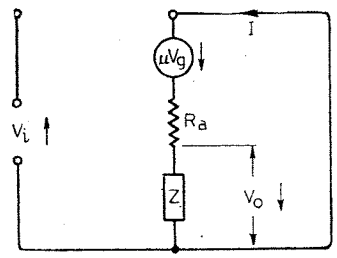


Fig. 3. Equivalent circuit in which Z is considered to include the effect of the external load impedance.

Then $I = \frac{\mu V_g}{R_a + Z}$ and $IZ = V_0$.

Also $V_g = V_i - V_0$, or $V_i = V_g + IZ$.

Hence voltage gain V_0/V_i is $\frac{IZ}{V_g + IZ}$

$$\text{or } V_0/V_i = \frac{IZ}{\frac{I \times (R_a + Z)}{\mu} + IZ} = \frac{Z}{\frac{R_a + Z}{\mu} + Z}$$

But $\mu = g_m R_a$ and thus

$$\frac{V_0}{V_i} = \frac{Z}{1/g_m + Z/\mu + Z} = \frac{g_m}{1/Z + g_m/\mu + g_m} = \frac{g_m}{Y + g_a + g_m}.$$

This is always less than unity.

The cathode follower is an example of an amplifier with negative voltage feed-back, and not, as is sometimes stated, an example of negative current feed-back. This follows from the fact that the voltage fed back is proportional to, and is indeed equal to, that across the load. A low output impedance is characteristic of all negative voltage feed-back circuits, whilst negative current feed-back leads to high output impedance.

Mr. J. G. Fleming was the first, so far as the author knows, to point out that the well-known results of the calculations above can be expressed most neatly in terms of conductances.

*Wireless World, July 1941, p. 176.

THE WORLD OF WIRELESS

POST-WAR TRAINING

A PROPOSED scheme of post-war training for wireless technicians that would involve close collaboration between the industry and the Board of Education was outlined at a recent meeting of the Radio Industries Club. The speaker, Brigadier F. T. Chapman, Deputy Director of Military Training (Technical) envisaged a scheme whereby boys would enter upon their training, not as independent students but as employees of wireless manufacturing firms. Periods at the technical training schools would alternate with spells of practical work at the factory. A similar "sandwich" scheme for entrants of rather riper age from secondary schools would provide trained men for the higher technical positions.

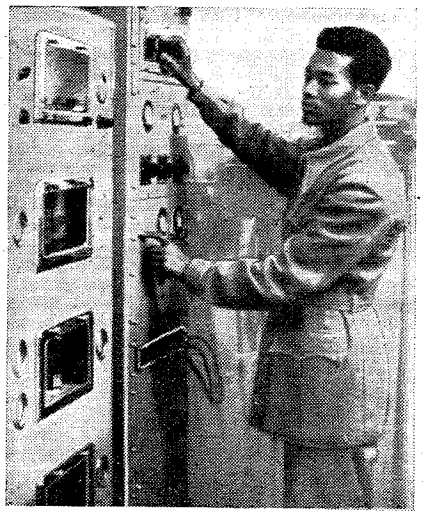
Brigadier Chapman did not consider that industry would be called upon to absorb all the wireless men from the Forces after the war; many of them would wish to return to their pre-war callings, and in any case the highly specialised and limited training that many of them had received in the Services would not necessarily fit them for positions in industry. However, Edward E. Rosen, in a speech of thanks, expressed the hope that industry would be able to obtain the services of the best of the demobilised men.

TECHNICAL AND SCIENTIFIC APPOINTMENTS

TO meet the need for an organisation to supply persons to fill posts of an administrative and managerial, professional or technical character, and, so far as possible, to ensure that persons having qualifications or experience which will be useful in such posts are used to the best advantage in the national interest, the Ministry of Labour and National Service has created what is to be known as the Appointments Department.

The department is divided into two branches. The Central (Technical and Scientific) Branch, which deals with, among others, professional engineers and scientists, has its headquarters at Sardinia Street, Kingsway, London, W.C.2 (telephone: Holborn 4300).

The Appointments Branch deals with persons of administrative, managerial, professional or technical qualifications and those whose remuneration would normally be in excess of £420 a year. It has 31 Appointments Offices throughout the country. The London office is at the above address.



AN ABYSSINIAN mechanic at one of the control panels of the Addis Ababa broadcasting station, which was built by the Italians during their occupation of the country. It was sabotaged by them when they retreated, but was soon repaired by the Royal Corps of Signals. Transmitting in the medium-wave band, it broadcasts daily in Amharic, Galla and Italian.

N.A.R.R. AND W.R.A. MERGER

IT was recently announced that the Wireless Retailers' Association and the National Association of Radio Retailers had reached an agreement to merge and form a new organisation which is to be called the Radio and Television Retailers' Association, Ltd.

The older of the two organisations is the W.R.A., which was formed in 1923. It was not until 1936 that the N.A.R.R. was formed.

In a joint statement, it is pointed out that these two radio retail trade organisations have for some time been discussing the possibility of co-ordinating their efforts, bearing in mind that the primary object of both is identical.

The statement continues: "By this concentration of effort, with its consequent elimination of duplication, the radio retail trade will now be able to speak with one voice, which is certain to prove of inestimable benefit to the trade as a whole."

The management of the new association will be in the hands of radio retailers elected from the general membership. Until a scheme for electing representatives to the council has been decided upon, a council of fourteen members (seven N.A.R.R. and seven W.R.A.) has been set up.

LUXURY RECEIVERS

THE President of the Board of Trade was recently asked in the House of Commons whether he was aware that Harrods Limited, London, S.W.1, were advertising new model luxury receivers at prices of 32 gns. and 59 gns., and whether it was the policy of his Department to permit the production of such receivers and the employment of valuable materials and labour thereon.

In reply, Capt. Waterhouse stated that it was not their policy to permit the production of such receivers and that the prices at which they were offered were being investigated by the Central Price Regulation Committee. In the meantime, Harrods had withdrawn the sets from sale.

WIRELESS MEN HONOURED

AMONG the many wireless men who were honoured in the King's Birthday List were F. W. Ogilvie and R. A. Watson Watt, on whom were conferred Knighthoods. Mr. Ogilvie was appointed director-general of the B.B.C. in succession to Sir John Reith in July, 1938. Until his appointment he was little known to the man-in-the-street; he was president and vice-chancellor of Queen's University, Belfast. Mr. Ogilvie resigned his director-generalship of the B.B.C. on January 26th this year

Sir Frederick Wolff Ogilvie, LL.D.

when, it will be remembered, the duties previously discharged by the D.G. were entrusted jointly to Sir Cecil Graves and Mr. Robert Foot.

It is not surprising that Mr. Watson Watt has been honoured when it is recalled how his name has been linked with radiolocation. He is at present scientific adviser on telecommunica-

The World of Wireless—

tions at the Ministry of Aircraft Production. He was previously superintendent of the Radio Department at the National Physical Laboratory. In the New Year Honours for 1941 he was created a C.B.

J. B. Clark, controller of the oversea services of the B.B.C., has been appointed a Commander of the Order of the British Empire (C.B.E.).

The appointment of R. P. Browne, secretary of the Radio Manufacturers' Association, as an Officer of the Order of the British Empire will meet with general approbation in the industry.

Sir Robert A. Watson Watt, C.B.

S. Butterworth, who will be remembered as the designer of high-efficiency tuning coils, details of which were given in this journal in 1925, has been appointed an O.B.E. He is a principal scientific officer at the Admiralty.

R. P. G. DENMAN

It was with regret that we learnt of the death during the Libyan campaign of Col. R. P. G. Denman, who was serving with the Royal Corps of Signals.

He will be remembered for his work at the Science Museum where, in his pursuit of quality reproduction, he constructed a 25ft. logarithmic horn which he mounted on the roof of the room in which it was to be heard. This horn was described in *Wireless World* of July 31st, 1929. Col. Denman was a versatile engineer, and in later years was concerned largely with direction finding and was responsible for the installation of the first Lorenz Blind Landing Beacon in this country.

BRIT. I.R.E.

When presenting the annual report of the council of the British Institution of Radio Engineers during the recent general meeting, the chairman announced that during the year nearly 380 applications for membership had been considered and that from them over 200 new members had been elected.

It was reported that a Professional Purposes Committee had been established, which is concerned with the professional status of radio and electronic engineers.

In the latest issue of the *Journal* of the Institution reference is made to the fact that although the German military authorities have decreed that textbooks on radio may not be dispatched to prisoners of war they do permit the sending of textbooks and courses on physics and mathematics. Accordingly, the Institution is arranging for appropriate dispatches to the British Red Cross Society and will be very pleased to receive any instruction material, including books, for prisoners of war who are preparing for the Institution's Examinations.

IN BRIEF

Radio Officers Praised

Admiral H. W. Grant, chairman of the Marconi International Marine Communication Company, in a statement made at the forty-second general meeting of the company, said: "I must end with a few words about our very gallant radio officers. Their devotion to duty and, alas, sometimes sacrifice of their lives, makes us proud to be associated with them." It is learned that since the beginning of the war and up to March 31st thirteen of the company's radio officers had been decorated for gallantry.

Obituary

It is recorded with regret that the death occurred a few weeks ago of William S. Purser, technical recording manager of Electric and Musical Industries. He was responsible for the installation and maintenance of the disc recording equipment and for studio acoustics in many parts of the world. Mr. Purser joined Marconi's Wireless Telegraph Company as a ship's operator in 1904, and during the last war was superintendent of instruction. In March, 1924, Mr. Purser joined The Gramophone Company. He initiated research

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSIONS

Country : Station	Mc/s	Metres	Daily Bulletins (BDST)
America			
WNBI (Bound Brook)	17.780	16.87	4.0‡, 5.0‡, 7.0.
WRCA (Bound Brook)	9.670	31.02	8.0 a.m., 10.45 a.m.
WRCA	15.150	19.80	4.0‡, 5.0‡, 7.0.
WGEO (Schenectady) .	9.530	31.48	10.45 a.m., 10.0†, 11.55§‡.
WGEA (Schenectady) .	15.330	19.57	3.0, 4.0, 8.45§‡, 10.55§‡.
WBOS (Hull)	11.870	25.27	1.0 a.m.
WBOS	15.210	19.72	4.0‡, 5.0‡, 7.0.
WCAB (Philadelphia) .	6.060	49.50	7.0 a.m.
WCBX (Wayne) ..	11.830	25.36	12.30 a.m., 8.30‡, 9.15†, 8.45§‡.
WCBX	15.270	19.65	12.30, 4.30, 8.30‡, 10.30.
WRUL (Boston) ..	9.700	30.93	1.15 a.m.‡.
WRUL	11.730	25.58	1.15 a.m.‡.
WRUL	11.790	25.45	12.30 a.m.‡, 10.30‡.
WRUL	15.350	19.54	12.30 a.m.‡, 6.0*, 10.30‡.
WRUL	17.750	16.90	6.0*.
WLWO (Cincinnati) ..	6.080	49.34	7.0 a.m., 8.0 a.m.
WLWO	15.250	19.67	4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0.
Australia			
VLQ6 (Sydney) ..	9.580	31.32	9.0 a.m.
VLG6 (Melbourne) ..	15.230	19.69	9.0 a.m.
China			
Chungking	5.950	50.42	4.0, 6.15.
	9.410	31.88	4.0.
	11.900	25.21	10.0 a.m. 11.30 a.m., 12.15, 1.30, 2.0, 4.0, 6.0, 9.15.
French Equatorial Africa			
FZI (Brazzaville) ..	11.970	25.06	5.45 a.m. 9.45.
India			
VUD4 (Delhi)	9.590	31.28	10.0 a.m., 2.30, 5.50.
VUD3	11.830	25.36	2.30.
VUD3	15.290	19.62	10.0 a.m.
Sweden			
SBO (Motala)	6.065	49.46	11.20.
SBT	15.155	19.80	5.0.
Turkey			
TAP (Ankara) ..	9.465	31.70	9.15.
U.S.S.R.			
Moscow	6.977	43.00	1.0, 7.0, 9.0, 10.30, 11.45.
Vatican City			
HVJ	5.970	50.25	9.15.
MEDIUM-WAVE TRANSMISSIONS			
Ireland	**kc/s**	**Metres**	
Radio Eireann.. ..	565	531	2.40‡, 7.45, 10.0.

It should be noted that the times are Double Summer Time—**two hours** ahead of GMT—and are p.m. unless otherwise stated. The times of the transmission of news in English in the B.B.C. Short-wave Service are given at the top of the next page.

* Saturdays only. § Saturdays excepted. † Sundays only. ‡ Sundays excepted.

work on electrical recording, to which subject he made valuable pioneer technical contributions.

We also record with regret the sudden death, at the age of 58, of A. P. ("Paddy") Boden, who had been chief works manager of the Gramophone Company since 1913. He was largely responsible for the installation of the various conveyors and plant for the production of receivers and radiogramophones.

A Link With the Past

The retirement from the Board of the Edison Swan Electric Company of Edward Gimingham brings to a close what is probably one of the longest service records in the industry. He joined the company in 1885 and would have completed 57 years' service one day after the date on which his resignation became effective. He made the first oscillator valve for Sir Ambrose Fleming, for whom he also conducted the experiments leading up to the production of the first practical radio valve.

Less Tin in Solder

To help in conserving our supplies of tin the British Standards Institution has recently issued a war emergency revision of BS 219, which deals with the composition of soft solders of the kind used in the making of wireless apparatus. The Specification discusses the various methods of effecting economy in tin, such as the use of substitute solders having little or no tin content. Copies may be obtained from the Institution, 28, Victoria Street, London, S.W.1.

Radio-Nations

With the expiration of the ten-year agreement between the League of Nations and the builders of the broadcasting station, Radio-Nations, at Prangins, the League has relinquished its right to the transmitter. It has, therefore, become an exclusively Swiss station owned by Radio Suisse S.A. de Télégraphie et de Téléphonie.

B.V.A. Valve List

A new edition of the B.V.A. List of Equivalent and Preferred Alternative Valves, which was published from the offices of *Wireless World* last November, has been prepared and should be available by the time this issue is in print. The price of the booklet remains at 1s., plus 1d. postage.

Convicted of Overcharging

Fines of £25 and £40 plus costs were recently imposed on J. & M. Stone, the multiple retailers, for charging 13s. 9d. in excess of the price of a 9s. 9d. Arcturus valve at Slough and for overcharging £2 8s. 10d. on a £20 wireless receiver at Cheltenham.

Change of Address

In order to accommodate the extra staff needed to deal with the ever-growing volume of work arising out of the extended programme for price control, the Central Price Regulation Committee has moved to larger premises at Queen Anne's Chambers, 41, Tothill Street, London, S.W.1 (Tel.: Whitehall 7010).

Minimising Jamming

To counteract the enemy's jamming of B.B.C. transmissions to the occupied countries listeners have been advised to construct a frame aerial, details of which have been given by the B.B.C.

B.B.C. News in English

The English news bulletin in the B.B.C.'s European Service, which was recently altered from midnight to 2215 (BDST) has now been discontinued. The one remaining bulletin in the European Service is transmitted at 1000, and the wavelengths used are marked with an asterisk in the following list of English bulletins broadcast in the B.B.C.'s World Services. Times are BDST.

0045: 31.32, 30.53, 25.68, 25.53.
0300: 31.32, 30.53, 25.68, 25.53.
0445: 31.32, 30.53, 25.68, 25.53.
0630: 40.98, 31.32, 30.53, 25.68, 25.53.
0815: 49.10, 42.46, 31.55, 31.25, 25.53, 19.82, 19.60, 19.49.
1000: 49.59*, 42.46, 41.96*, 41.49*, 31.75*, 31.55, 30.96*, 25.53, 24.92*, 24.80*, 19.82, 19.60, 19.49, 19.42, 16.84.
1300: 25.53, 19.82, 19.49, 19.42, 16.84, 16.77, 13.97.
1500: 25.53, 19.82, 19.49, 19.42, 16.84, 16.77, 13.97.
1800: 31.75, 25.53, 19.82, 19.66, 19.49, 16.84, 16.77.
2000: 31.55, 31.25, 25.53, 19.82, 19.66, 16.77.
2245: 31.25, 25.68, 25.53, 19.82, 16.77.
2315: 31.32, 31.25, 30.53, 25.68, 25.53, 19.82.
2345 (excluding Sundays): 31.32, 31.25, 30.53, 25.68, 25.53, 19.82.

I.E.E. Officers

Professor C. L. Fortescue, O.B.E., M.A., of the City and Guilds College, has been nominated president of the Institution of Electrical Engineers. The nominee for the vice-presidency is P. Good, C.B.E., director of the British Standards Institution.

The committee of the Wireless Section nominated the following, who have been duly elected, to fill the vacancies which will occur on the committee on September 30th: chairman, R. L. Smith-Rose, D.Sc., Ph.D. (National Physical Laboratory); vice-chairman, H. L. Kirke (B.B.C.); ordinary members of committee: A. D. Blumlein, B.Sc.(Eng.) (E.M.I.); E. C. S. Megaw, B.Sc. (G.E.C.); and J. A. Smale, B.Sc. (Cable and Wireless).

Institute of Physics

At the annual general meeting of the Institute of Physics on May 28th, the following were elected to take office on October 1st: president, Prof. Sir Lawrence Bragg; vice-presidents, Dr. W. Makower and T. Smith; honorary treasurer, Major C. E. S. Phillips; honorary secretary, Prof. J. A. Crowther.

Institution of Electronics Meeting

Three papers on "Thermionic Emission of Oxide Coated Cathodes," read at the recent meeting in Manchester of the Institution of Electronics, are to be published in the official organ *Science Forum*. Non-members who desire copies should apply to the Secretary, A. H. Hayes, 64, Winifred Road, Coulsdon, Surrey.

Electronics

The second meeting of the Electronics Group of the Institute of Physics has been arranged for Wednesday, July 8th, at 5 o'clock, in the Lecture Theatre of the Royal Institution, Albemarle Street, London, W.1. There will be a discussion on cathode-ray tubes.

PREMIER RADIO

I.F. TRANSFORMERS, IRON CORED
450–473 kcs., plain and with flying lead, **5/6** each.

ELECTROLYTIC CONDENSERS
8MF 320 v. **Wet Can** type, **3/-** each.
25MF 25 v. ..... **1/6** 50MF 12 v. **1/6**
50MF 50 v. ..... **2/6** 8MF 125 v. **1/6**
15MF 50 v. ..... **1/-** 15MF 100 v. **1/3**

U.S.A. Type Valves. 1A5G, 1E5G, **15/-** each: 6V6G, 6K7G, 24A, **12/10** each; 1F5G, 2A5, 6A4, 6B6G, 10, 26, 31, 35/51, 55, 71A, 81, 82, **10/-** each. Many other types available. Send for lists.

Valve Screens for International and U.S.A. types, **1/2** each.

PREMIER REPLACEMENT VALVES
4-volt. A.C. type, 5-pin. ACHL, ACSG, **5/6** each.

RESISTANCES
Met. Vick. Resistors, assorted valves, our choice, **2/6** per doz.
2,000 ohms 25-watt Res., with 5 Tapping Clips, **2/-** each.
1 ohm ± 1%, suitable for Bridges, **5/-** each.
1,000 ohm Wire Wound Potentiometers, **3/11** each.

Mains Resistances. 660 ohms .3A Tapped. 360 × 180 × 60 × 60 ohms, **5/6** each.
1,000 ohms .2A Tapped 900, 800, 700, 600, 500 ohms, **4/6** each.

H.T. Eliminators. 150 v. 30 mA. output, **41/6.**; ditto, with 2 v. ½ A. charger, **52/6.**

PREMIER 4-watt A.C. AMPLIFIER
Each Amplifier is completely wired and tested. Selected components, specially matched valves and 8in. energised speaker, **£5 5/-.**

PREMIER MICROPHONES
Transverse Current Mike. High-grade large output unit. Response 45–7,500 cycles. Low hiss level, **23/-.**

Moving Coil Mike. Permanent magnet model requiring no energising. Response 90–5,200 cycles. Output .25 volt average. Excellent reproduction of speech and music, **63/-.** Super model, **£5 5/-.**

Microphone Transformers, 10/- each.

Crystal Microphone. Rothermel D. 105, 63/-.
MR1 Universal 4 watt output transformer tapped for Power, Pentode and Push Pull, suitable for 2 and 7/9 ohms speech coil, **7/6** each.

MOVING COIL SPEAKERS
Celestion, 8in. P.M. Speaker, **25/-.**
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Fits Standard ¼in. Condenser Shafts, increases ratio six times, **2/9** each.

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Westinghouse Rectification, complete and ready for use. To charge 6 volts at 1 amp. (also tapped for 2 and 4 v.), **29/6.**
12 v., 1 a. (also tapped for 2 and 6 v.), **37/6.**
6 v. at 2 a. (also tapped to charge 2 and 4 volts), **48/-.**

MATCHMAKER UNIVERSAL OUTPUT TRANSFORMERS
Will match any output valves to any speaker impedance. 11 ratios from 13–1 to 80–1. 5/7 watts **20/-.** 10/15 watts, **26/-.**

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169, FLEET STREET, E.C.4. *(Central 2833.)*

OPERATORS IN THE MAKING

Aptitude for Learning Morse

By "RAW-CW"

THERE has been a great deal written on the learning of morse, some authors advocating this or that method for rapid progress, others claiming short cuts by special systems. The novice who considers the idea of learning morse is often led to think that it can be mastered in a couple of weeks—just like some game or simple musical instrument. Beginners are soon disillusioned, and many, unless they are being compulsorily trained, give it up almost as soon as the rudiments are grasped, realising that there is no short cut, but a lot of hard work ahead.

Little, if anything, has been published about the time taken to attain any particular speed, or the various results that can be expected by any given method or any particular type of trainee or the choosing of trainees, their ages, and so on.

It has been my personal responsibility for the correct training of upwards of a thousand students, both men and women, for the various services—Army, R.A.F., Merchant Navy and Admiralty Shore Wireless—and a great deal of valuable information has been collected during their instruction. This information can be brought under three headings:—

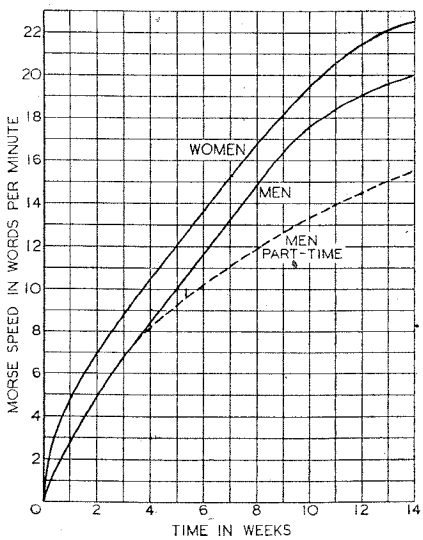
(1) Choice of candidate for training.
(2) Method of training.
(3) Results obtained.

I do not propose to dwell on the method of training as I mentioned earlier that this has been discussed at some length, although there are certain ways that I have proved to be satisfactory, in spite of claims to the contrary.

Men *versus* Women

Dealing with the choice of trainees first, I have found women far quicker than men at learning morse, and they take to it much more easily. I have had girls of 22 years attain twenty-four words per minute in six weeks, which is much better than any mere man ever accomplished. They were outstanding girls, of course.

Candidates should have normal hearing, neat hands, preferably right-handed. Their handwriting should be large and well rounded, a sample being taken at the interview. They should have a good memory, be inquisitive, have a sense of rhythm, not necessarily being able to play an instrument, but an interest in music is a good sign. They must be observant and diplomatic, being able to hear much and say nothing. Hobbies give good indications, particularly those of a mechanical or scientific nature requiring some patience. Candidates must not be easily bored, and have average intelligence. Ages for men are 25-35 years; married men get along best. For women, 20-35 years; unmarried or unattached for preference.



Graphs showing reception progress of men and women trainees.

It would be an excellent idea to have candidates' handwriting analysed by an expert. I did this with many of my students with gratifying results, as other qualifications were confirmed, and time could, therefore, be saved at an interview.

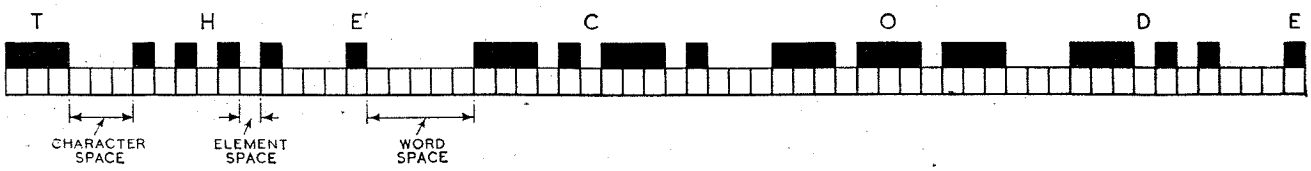
What will be of great interest to those anticipating learning morse is the results I have obtained, and a reference to the accompanying graph will illustrate my points. Firstly, instruction should be "gentle" for the initial four weeks. Let the morse sink in! Let them think in morse! Don't rush it. I have proved that a couple of hours a day for this period is sufficient, as there was no difference in the progress of part-time students doing six hours a week compared with full-time students doing seven hours a day.

Youth *versus* Age

Younger students appear to get hold of morse quicker in the early stages, both receiving and sending, but, due to a natural youthful tendency to speed, writing suffers—they are wont to scribble quickly to impress onlookers when taking down, and are always in a great hurry to send fast on the key. The older and more stable students as a rule take their time, and are consequently slower *at first*. Close examination of my records shows that the older ones ended their courses on the average one or two words per minute better than the youngsters, and that their keying technique was superior also.

I have found since that most of the best operators I have trained belonged to the older groups, and, personally, I think that the youngsters become indifferent and lose their enthusiasm easily, especially later on, when watch-keeping is to be carried out.

Most trainees appear to reach a "stagnation point" between the seventh and ninth weeks. This "psychological pause," as another *Wireless World* writer has called it, is a very real state, and it usually corresponds to a speed of 15 w.p.m. Trainees are apt to lose heart, become fed up, and seem to think they will never get along to fast morse. The only cure is to saturate them with fast morse; never mind if they cannot read it, so long as they sit for a few hours with the telephones on. Appar-



Correct spacing is vital to good operating. As is shown by this graphical key (reproduced from the *Wireless World* Morse Chart), the dot is the basic unit. The dash is equal in duration to three dots. Between the elements of a character, spacing is one dot; between characters of a word, three dots; between words, five dots.

ent stagnation may last for many days, but as a rule the trouble disappears within a week. It is the instructor's job here to encourage and help the students by any means he can, such as sitting with them and effortlessly writing down in perfect handwriting a burst of 35-w.p.m. copy, which sounds to the trainees very fast indeed. When they see it can be done they soon make up their minds to get over the turning point, for that is what it is—the change from novice to semi-expert. The trouble is to get instructors who can do this, and who can convey that nonchalant air of quiet efficiency. I have not noticed this psycho-state amongst women.

Details of Tests

All my tests were taken on five-minute transmissions counting five letters to a word; any errors over ten for the test would mean a wash-out and a slower transmission to be taken. I also had tests on mixed figure-cipher-plain copy, for which a formula had to be applied to obtain the resultant speed. Comparisons with separate tests showed almost no difference. The formula for this "mixed pickle" (as the students called it) was:—

$$\frac{x+\frac{2x}{13}}{T}$$

where x is number of groups (five-letter, figure and P/L groups), and T is time in minutes. It was very unpopular!

The following table gives the weekly progress of men trainees doing not less than six hours' receiving and one hour sending practice daily after the first four weeks, under fairly rigid supervision.

Week.	Sending (w.p.m.).	Receiving (w.p.m.).
1	6.8	3
2	9	4.8
3	10.6	6.5
4	12.2	8.2
5	13.7	9.9
6	15	11.5
7	16.2	13.2
8	17	14.9
9	17.8	16.3
10	18.4	17.4
11	19	18.2
12	19.5	18.8
13	20	19.3
14	—	20

Progress in sending is, of course, more rapid than in receiving. The table applies to plain language tests, counting five letters to a word.

Radio Receiver Circuits Handbook, by E. M. Squire.—In this book, which is a second edition, a summary of the general theory of the most important and commonly used circuits in modern radio receivers is presented. Notes are given on the best methods of operating the circuits described and on the faults most likely to occur in them. For ease of explanation the radio receiver is split up into stages. The book does not attempt to be in any manner mathematical, treatment of the subject matter being entirely from the practical angle. Pp. 104. 50 diagrams. Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 5s.

BOOKS ON WIRELESS

issued in conjunction with "Wireless World"

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Letters to the Editor

Cheaper Hearing Aids : Is Wired Wireless Wanted? : Are Service-men "Engineers"?

"Hearing Aids for the Million"

I CERTAINLY agree with Mr. Balbi that what is required to-day is a first-class hearing aid at a reasonable price, such as an average man can afford.

I consider that the various hearing aids are at present much too expensive, and some effort ought to be made to mass-produce them at a very much lower figure.

It would be very satisfactory if the large wireless companies would take up the matter, and mass-produce hearing aids based on the best points of all the existing types.

There is also an urgent need for standard batteries of first-class quality, and they should be mass produced also.

Such an arrangement should not be beyond the powers of scientific instrument makers and designers in this Year of Grace 1942.

MONTROSE,
President : The National Institute for the Deaf.

I HAVE read with interest Mr. Balbi's recent article on hearing appliances in your publication.

If and when the wireless industry turns its attention to the manufacture of valve hearing aids, I hope consideration will be given to the standardisation of such parts as plugs, fittings and batteries by some independent body, so as to avoid the confusion and irritation to the deaf which prevail to-day through the lack of such co-ordination.

G. W. TILBURN,
Acting Secretary : The National Institute for the Deaf.

MR. BALBI, writing in the May issue, touches on very dangerous ground when he suggests mass production and distribution through wireless dealers.

The average wireless dealer, with a few exceptions, is a salesman, interested in sales rather than technicalities. He wants good sets, with a fair profit, and no "comebacks." To expect him to carry stocks of hearing aids, prepare himself to deal with their care and upkeep, and above all to deal with deaf people in the manner they require, is, to my mind, asking too much. A deaf person requires far more tact and reasoning with than the wireless dealer has time for.

There is another side to the case which Mr. Balbi, in his eagerness for low priced mass-produced apparatus, seems to have forgotten. No two deaf people require exactly the same treatment, and hardly any require mere amplification, but rather correction or help in some part of the audio-frequency scale. It is too much to expect them to be helped by an "over the counter" sale.

The present position of the hearing-aid market is far from satisfactory. I have had over ten years' experience in the trade, and being deaf I use an aid myself, and I can safely say that amongst well over a dozen different types which I have tested only three are worthy of the name ; of those two are valve types and one carbon.

R. W. LOWDEN.
Camberley, Surrey.

Wired Wireless Broadcasting

MINORITIES always have been, and always will be, noisy. That small section led by Mr. P. P. Eckersley which is setting up a clamour for "wired wireless" is no exception. Amidst all the clamour, however, is the unmistakable sound of an axe on a grindstone. Is the ground being prepared for vested interests ?

If wireless transmission had failed to bring to the average listener an adequately acceptable version of the broadcast programme there would be a case for the so-called wired wireless. No one, not even Mr. Eckersley, has said that the wireless propagation of programmes is a failure. The mass-produced type of radio receiver has faults of which we are all well aware, but I am sure that these faults will be rapidly eradicated when science returns to peace-time pursuits. In any case the shortcomings alluded to are not of sufficient magnitude to prove the "need" for wired wireless.

One of the main planks in the platform of the wired wireless party is, "Clear the air for essential services." This is undoubtedly a clarion call, calculated to evoke a response from the average patriotic citizen but—does not bear investigation.

In the first place, broadcasting itself is deemed by the Ministry of Information to be an essential service, so presumably it must go on.

Secondly, although there are more service transmitters (Allied and enemy) on the air now than at any other time, it is quite wrong to hint that the number of broadcast stations would require to be reduced in order to make way for more Service stations. The radio spectrum is "as wide as the ocean" and from recent practical experience and from information at my hand I have no hesitation in saying that there is more than room for all.

Recently we have been asked to contemplate a post-war world filled with "jostling side-bands." Are we fighting this war in order to achieve chaos ? Surely not. International agreement in any sphere will, I trust, mean very much more than it has done in the past, otherwise we shall have another war on our hands before many years.

Wireless broadcast is far-reaching and is as universal as the very air which we breathe. Wired broadcast with its limited selection ceases to be a "broadcast" at all since it is diverted only to certain reception points and consequently carries some curtailment of the freedom of the individual as well as the danger of exploitation.

A. REDPATH.
Edinburgh.

The Editor does not necessarily endorse the opinions of his correspondents

Status of Technicians

MR. C. S. FOWLER (June *Wireless World*) suggests that there are many who describe themselves as radio engineers who have merely a good practical knowledge of a few commercial receivers and are able to locate and repair the faults that occur in these sets.

In my opinion those who can locate faults, repair, modify, adapt and obtain as good or better performance from a receiver than when new, are entitled to describe themselves as radio engineers.

Plymouth. E. J. ELLIOTT.

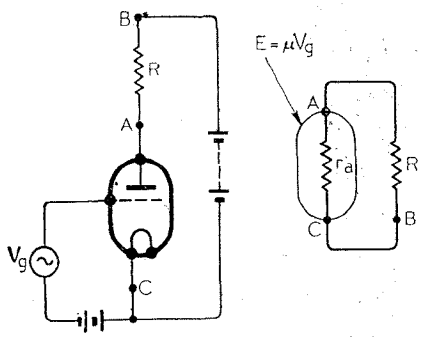
[We recognise that high standards of intelligence, knowledge and training are needed for the competent maintenance of all kinds of wireless apparatus, and have often urged that those qualified for such work deserve a higher status than they generally enjoy at present. But we cannot agree that it is desirable to extend the generally accepted and fairly

precisely defined meaning of the word "Engineer" to cover all those engaged in such work. Admittedly, "Service-man" is not an attractive designation; a better word is wanted. —ED.].

Valve Equivalent Circuit

THE author of this article (May *Wireless World*) seeks to show the limitations of the equivalent circuit for a valve amplifier. If, however, the equivalent circuit is restricted to the alternating components of the voltages and currents a true "equivalent" is possible.

The valve circuit of (a) with AC voltage of V_g applied to the grid is the equivalent of an alternator, the EMF of which is equal to μV_g volts and having an internal armature resistance of r_a ohms. The equivalent



(a) (b)

circuit is shown at (b) and it will be seen that the points C and B are at the same AC potential and the *potential difference* between A and C is the same as the voltage developed across the load resistance R. These are exactly similar conditions as exist in the actual valve circuit.

Alternating component of anode current, i_a, is given by $\frac{\mu V_g}{r_a + R}$.

Voltage across load resistance $= i_a R$

$$= \frac{\mu V_g . R}{r_a + R} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Voltage across A and C

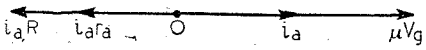
$$= \mu V_g - i_a r_a$$

$$= \mu V_g - \frac{\mu V_g . r_a}{r_a + R}$$

$$= \mu V_g \left(1 - \frac{r_a}{r_a + R}\right) \quad \ldots \quad \ldots \quad (2)$$

The expressions (1) and (2) give identical numerical results. Further, the vector diagram of the equivalent circuit shows that the voltage across the valve $(\mu V_g - i_a r_a)$ is in antiphase with the voltage across the load, $i_a R$.

If R is zero, r_a remains unchanged and $(\mu V_g - i_a r_a)$, the voltage across the valve, becomes zero. In the same way, the PD of a short-circuited battery or generator is zero but the internal resistance is still present and the whole of the EMF is required to overcome the internal voltage drop.

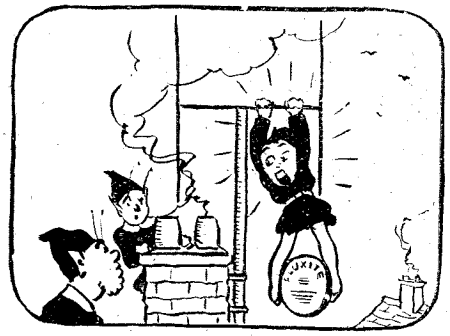


The Polytechnic, London, W.1. W. H. DATE.

I THANK your correspondents for pointing out in no uncertain terms the fact that I committed a serious fundamental error in removing the source of EMF of the valve generator from the valve whilst leaving its internal resistance behind. I must, however, disabuse "Cathode Ray" of the notion that I am in the habit not only of doing this, but of adding to the sins of which I have already been found guilty by connecting a large condenser across the disembodied source of alternating EMF. What most "reasonably alert classes" realise is that the valve equivalent circuit does not account for the power transformation which takes place upon application of a voltage to the grid of a valve. While congratulating "Cathode Ray" on his fortunate upbringing, I hope he will at least cede me this; that on the fundamental question of power the "equivalent circuit" is definitely not equivalent. Its use would lead one to suppose that a valve delivering AC power to a load was also suffering an increased internal loss, whereas, of course, its internal loss is reduced by the amount of AC power appearing in the load. The idea of a negative dynamic resistance was put forward by me in order to provide a theory which would satisfy the question of power. It was not my object to cause students' heads to reel, neither did I suggest that calculations were in any way expedited by the use of this concept. Approximate mathematical formulae are frequently extremely useful, but their application must obviously be restricted to those cases in which the assumptions and approximations made are justified. My object was to point out such limitations in the simple equivalent circuit of the valve—not to condemn its legitimate use. The expression 180 deg. out of phase, as used in my article, should not have caused any confusion.

Evidently Prof. Howe agrees with the non-equivalence of the simple circuit from the power point of view, since he re-states the relevant arguments. Although somewhat scathing in his denunciation of my cavalier treatment of the valve generator he takes far greater liberties than I should have dared in discarding it completely and substituting a special device for converting DC power into AC. HAROLD J. BOYLAND.

London, S.E.21.



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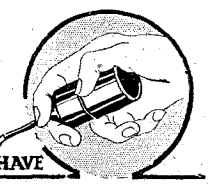

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Brains Trust

Solution to Problem No. 2

(*See page 161*)

As the second part of your question is the easier, we shall deal with it first. The answer is, Yes! Nikola Tesla, the celebrated Serbo-American engineer, remembered chiefly for his induction coils, carried out large-scale experiments with it in Colorado towards the end of the last century.

Backed by Pierpont Morgan and the Canadian Niagara Power Company, he built on a high plateau a station with an aerial 70 metres high. He claimed that his transmitter could handle a power of 200 kW; yet this can hardly have been a continuous rating, as valves were not yet known. Huge induction coils and spark gaps were his means of producing RF energy, and he employed long waves of about 20 km. wavelength. Using only 15 per cent. of full power, he succeeded in operating light bulbs and small motors at a distance of 15 miles from his transmitter. The receiving aerial was a short length of wire or a small raised metal plate connecting to a series resonant circuit consisting of a large tuning coil, the load, and a counterpoise plate or earth.

As a result of this and other experiments, Tesla took out numerous patents for "wireless transmission of electrical energy over great distances." Friends backed him in his scheme for an electrical "world system." But let Tesla explain its purpose in his own words, which are to be found in the *Electrical World and Engineer* of March 5th, 1904. He proposed to "distribute 10,000 h.p. under a tension of over 10^6 volts," which he claimed to be "able to produce and handle with safety. This energy will be collected all over the globe, preferably in small amounts, ranging from a fraction of one to a few h.p. One of its chief uses will be the illumination of isolated houses."

Now Tesla's conception of wireless waves had been anti-Hertzian, i.e., he did not agree that they were electromagnetic waves, having the properties of light. Indeed, whereas Hertz had been working with the now resurrected decimetre wavelengths, Tesla's waves were many kilometres long. Tesla stated that by choosing a frequency such that the earth's diameter became an odd multiple of a quarter-wavelength, stationary waves appeared on the earth's surface when he transmitted. We may take it in the light of modern ideas that this was due to interference between different ground waves. Energy could thus be obtained by connecting two points on the earth at different potentials, preferably in an antinodal zone, i.e., a zone where the alternating potential difference had maximum amplitude. Tesla put it down to human stupidity and vested interests that his scheme was not at once applied in practice.

It is, of course, true that a hypothetical power company radiating its product in all directions would have some difficulty in tracking power thieves, but the scheme might well founder on the rocks of more fundamental difficulties: these are, in fact, the problems of to-day's power companies, i.e., chiefly the problem of fluctuations in demand, increased manifold by the characteristics of the radiation field, and the need for frequency changing. For even with Tesla's moderate frequency of 15 kc/s ($\lambda = 20{,}000$ m), it would be necessary to use frequency multiplication between the generating house and the transmitter, and again between the receiving aerial and consuming device; though as the latter might utilise the RF energy directly, frequency division at the receiver might be dispensed with.

Inefficiency of Wireless

Let us compare the overall efficiency of a wireless system with that of wired power transmission. The main factors involved are as follows:—

1. Conversion of DC or 50 c/s energy into energy at radio-frequency: 78.5 per cent. is the best figure obtainable from class C push-pull amplification, neglecting heating and excitation energy.

2. Transfer of energy from amplifier load circuit into aerial: the theoretical maximum is 50 per cent., assuming correct matching. Neglecting losses in the aerial and, for the moment, losses in the field, the next problem is to estimate the efficiency of reception:—

3. This is the inverse of 2, i.e., transfer of energy from the receiving aerial to the load or frequency divider. In view of reflection losses, only half the abstracted energy is passed into the lead, given proper matching; hence the efficiency is 50 per cent., as in 2.

4. Conversion of RF energy into 50 c/s or DC energy. This may not be absolutely necessary, as mentioned above. Anyway, no figures being available, let us assume the same as in (1), that is, 78.5 per cent. efficiency.

Hence, the overall efficiency of our system is $78.5 \times 50 \times 50 \times 78.5 = 15$ per cent., compared with well over 90 per cent. for wired power transmission.

The foregoing assumes that all the energy radiated by the transmitter is absorbed by the receiving aerial, so the energy would have to be confined to a narrow beam no wider than half a wavelength by the time it reached the receiving aerial. This involves the use of reflectors and UHF to minimise reflector size, thus restricting the system to point-to-point operation over virtually an optical range. Yet this would spoil the project of one of its main charms, i.e., wireless power distribution over a wide area. Further, although short waves are used greatly in long-distance communication, a power system could not afford the uncertainties and losses of reflection at the ionosphere on which SW transmission relies for bridging large distances.

Hence, it is necessary to return to Tesla's long waves, as these are guided by the earth's surface in their propagation. Unfortunately, even if losses due to this guide and radiation into the ionosphere were negligible, the energy density of transmission falls off inversely with distance.

Although it is conceivable that by utilising yet untapped reservoirs, e.g., tidal currents, for generating electricity a much lower overall efficiency than 15 per cent. could be made acceptable on economic grounds, the "service area," i.e., the area in which the energy density would be sufficient to light a few lamps at least, would be diminutive. Again, a heavy consumer would upset the field for miles in the vicinity. Then there is the question of interference with the communication bands. There are further difficulties, but we leave them to you to think of, and to solve along with the ones indicated by us.

In conclusion, we must admit that we have heard of only two other experiments with wireless power transmission: some time before the war, a Continental broadcasting station discovered and prosecuted a man for using some of its energy to light his house, only a few hundred feet from their aerial mast. Although he was probably only poaching on the near-field (induction) and not on the radiation proper, the court's judgment went against him.

The other experiment made in the U.S. was one in which intensive radiation produced an artificial aurora in an enclosure filled with moist air. So there is an idea for city lighting, when victory is won!

Radio Compactum for Ships

Installation Work Abolished

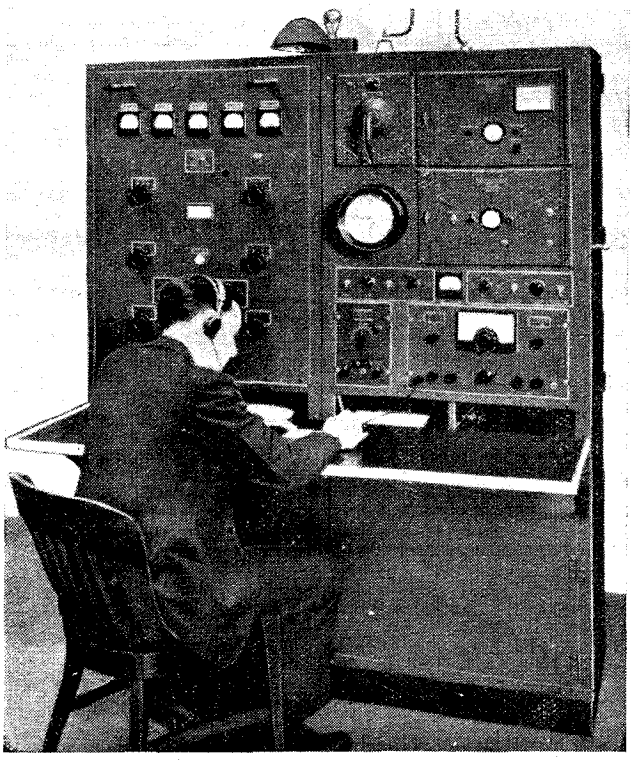
As in the case of the domestic wireless receiver, a ship's wireless equipment started life as a collection of bits and pieces connected together by odd lengths of wire; but whereas the domestic receiver has long since evolved into a compact unit all ready to be brought home and plugged into the mains, it is only recently that this degree of evolution has been achieved aboard ship. In the case of a ship it has been mainly the transmitter that has consisted of a number of separate instruments screwed to deck or bulkhead, as the receiving portion of the apparatus achieved unity in the years following the last war.

The fact that radio equipment has always consisted of a number of separate parts has meant that it always took a considerable amount of time and labour to install. This has not been entirely the fault of the radio designer, since the size and shape of cabin allocated to wireless, even in ships of the same tonnage, has varied greatly. All this has been altered overnight owing to the emergency programme for building cargo ships which has been formulated by the Maritime Commission of the U.S.A. as part of that country's national defence programme.

The production of standardised cargo ships has led to the development by the Federal Telegraph Company of what, according to a recent edition of *Electrical Communication*, may be termed a plug-in ship's radio transmitter and receiver, insomuch as the whole apparatus is built as one compact unit, even including the operating table, and it is virtually only necessary to move the unit into the wireless cabin, connect up the aerial and earth, and plug into the ship's mains. Thus installation work is virtually abolished, as the simple operations just mentioned only take a fraction of the time that was normally devoted to putting wireless apparatus in a new ship.

Emergency Crystal Receiver

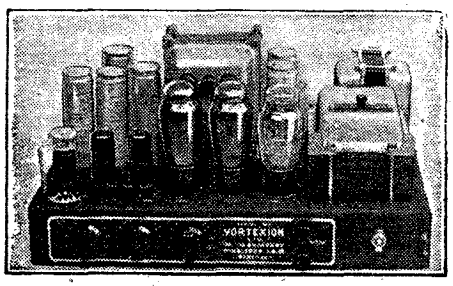
The Federal Company's apparatus consists of a 300-watt transmitter. A separate converter driven by batteries can be used for emergency working, the output then being 50 watts. The transmitter is so arranged that it can be quickly switched over to give five different wavelengths between 600 and 850 metres, but the receiver tunes continuously from 450 to 2,000 metres. A crystal receiver is also fitted to meet the requirements of the law, which also calls for an auto-alarm device. DF is also included. All panels are hinged so that the apparatus is readily accessible for maintenance, this again saving a tremendous amount of time and labour when servicing is needed.



In this one unit is embodied all the radio gear for a cargo vessel, including even the operating table. It is intended to save valuable time in installation work, as only aerial, earth and mains connections are necessary to complete the job.

VORTEXION

50w. AMPLIFIER CHASSIS



A pair of matched 6L6's with 10 per cent. negative feed-back is fitted in the output stage, and the separate HT supplies to the anode and screen have better than 4 per cent. regulation, while a separate rectifier provides bias.

The 6L6's are driven by a 6F6 triode connected through a driver transformer incorporating feed-back. This is preceded by a 6N7 electronic mixing for pick-up and microphone. The additional 6F5 operating as first stage on microphone only is suitable for any microphone. A tone control is fitted and the large eight-section output transformer is available in three types:—2-8-15-30 ohms; 4-15-30-60 ohms or 15-60-125-250 ohms. These output lines can be matched using all sections of windings and will deliver the full response (40-18,000 c/s) to the loud speakers with extremely low overall harmonic distortion.

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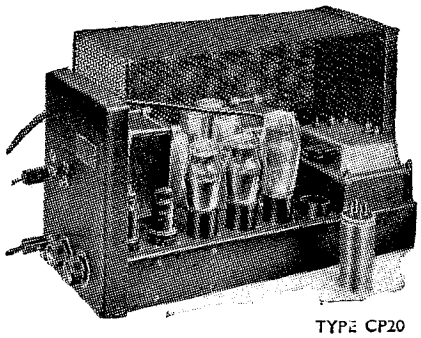


TYPE CP20

This small Portable Amplifier operating either from AC mains or 12-volt battery, was tested by the "WIRELESS WORLD," October 1st, 1937, and has proved so popular that at customers' demand it remains unaltered except that the output has been increased to 17.2 watts and the battery consumption lowered to 6 amperes. Read what the "Wireless World" said:—

"During tests an output of 14.7 watts was obtained without any trace of distortion so that the rating of 15 watts is quite justified. The measured response shows an upper limit of 18,000 c/s and a lower of 30 c/s. Its performance is exceptionally good. Another outstanding feature is its exceptionally low hum level when AC operated even without an earth connection. In order to obtain the maximum undistorted output an input to the microphone jack of 0.037 volt was required. The two independent volume controls enable one to adjust the gain of the amplifier for the same power output from both sources, as well as superimpose one on the other or fade out one and bring the other up to full volume. The secondary of the output transformer is tapped for loud speakers or fine impedances of 4, 7.5 and 15 ohms." Prices

AC and 12-volt CHASSIS with valves, etc.	£12 12 0
AC only CHASSIS with valves, etc.	£8 18 6

Gauze Case for either chassis, 12/6 extra.

Plus 25% War Increase on all above prices.

Orders can only be accepted against Government Contracts.

Vortexion Ltd., 257, The Broadway, Wimbledon, S.W.19. 'Phone: LIBerty 2814

RANDOM RADIATIONS By "DIALLIST"

Tap Water or Distilled?

IN all the textbooks and the popular handbooks you'll find it laid down categorically that all kinds of horrible things will inevitably happen to secondary cells if anything but distilled water is used for mixing the electrolyte in the first place and for topping up the cells subsequently. I wonder how many writers of the aforesaid books have founded their heavy warnings against the use of tap water on the results of practical experiments. Most of them, I'll wager, have been content to bank on to what others have written before them. Personally, I don't think it matters two hoots whether you draw your water just as it comes from the tap or buy it distilled from the chemist. I think I'm right in saying that for years the G.P.O. people have used tap water widely for their secondary cells without noticing any ill effects. Readers will no doubt have tried both *aqua pura* and *aqua impura*; results of experience would be welcome. I, personally, never hesitate to use tap water unless it's of the very hard variety. Even then all seems to be well if you boil it first and allow it to cool and settle before putting it into the cells.

'Ware Lights

Have you ever seen or heard an accumulator explode? I have, and, believe me, it's literally a shattering experience. You may get away for years with striking matches or smoking cigarettes near accumulators charging on the bench; but it's a risky thing to do. Hydrogen may be given off in considerable volume, and hydrogen mixed in the right proportion with air forms an explosive of no mean potency. I mentioned this the other day to a non-electrical friend who had just pulled out his cigarette case in a small room containing a number of secondary batteries under charge. "By Jove!" he said, "that explains a mysterious happening in my garage just before the war started." He told me that a big starter battery was on charge, standing on a table near the wall. Suddenly there was a terrific report; the battery was shattered to atoms and a hole was blown clean through the wall of the garage. As, luckily, no one was in the place at the time, it can't have been a cigarette that was to blame. In all probability the trouble was caused by a small spark at some loose contact.

Trouble Saving

LAST time I was at home for a brief spot of leave I put in a trickle-charger for the accumulator of the battery-operated portable which my better half regards as her radio stand-by. They're not always easy to come by, but you can find them if you look around. Mine is a Varley, a neat, compact little gadget that provides for a charging rate of either 0.5 or 0.25 amp. Some people, I know, hook up the trickle-charger permanently to the accumulator and turn it on with the latter in the normal position in the set, but I don't hold with that. It is far better to take the accumulator out of the set for charging and to stand it during the process on a tile, a piece of glass, or an old dinner plate. If you leave it in its compartment, acid splutterings eventually play havoc with the case of the set; the first intimation one friend of mine (who did his charging in the way I don't recommend) had that anything was wrong was when he picked up his set one day and *both* batteries fell out through the acid-rotted bottom of their compartment.

A Good Investment

The trickle-charger is a sound wartime investment for those who have battery sets either for general use or as stand-bys—and the number of folk who do have them nowadays is pretty big. It means a saving in both expense and trouble; you haven't the bother of carrying (in these days of infrequent deliveries or none at all) your cells to and from the charging station. And the trickle-charger is the simplest thing in the world to use. Just hook it on and plug it in, stand your accumulator on a plate or what not, switch on and leave it to do its work. As a precaution always wipe over the case of the charged cell carefully before you return it to its compartment, *and* keep the terminals lightly Vaselined. I find that the most satisfactory plan is to own two small cells. Each does three days or so in the set and then comes out for a day's charging. The loading of trickle-chargers is very small, and they are a most economical means of keeping filament batteries up to the mark. They are so simple to use, too, that I don't think you'll find much difficulty in instructing even those with the haziest knowledge of electricity in their handling.

GOODS FOR EXPORT

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export

Servicing After the War

WITH the numbers of men in all the Services who have undergone or who are receiving training in electricity and wireless, there should be no dearth of first-rate radio service-men when the war has been brought to the successful end for which we all long. We may now be going through a rather irritating time, when radio repairs take a long time, if we can get them done at all. That's because so many of the men who would nowadays be engaged in keeping the receiving sets of the people in running order have been called up for other service. But any present hardships will be amply compensated for when peace returns. The man who was already a service-man of sorts in peacetime will have had in the Army a far more thorough training than ever he had before, and he'll return to civil life thoroughly competent to do his job. And thousands of others who, before joining up, knew no more about a receiver than how to switch on and tune in a broadcasting station, will leave the Forces well equipped with theoretical and practical knowledge. One can safely foretell a new era.

Queer Mixture

It is surprising to find to what a diversity of callings of the most unlikely sorts men belonged in civil life who are now well grounded in theory and wizards at spotting and rectifying the most difficult faults. Recently I heard a masterly disquisition on certain abstruse uses of valves given by one who was a hatter in "Civvy Street." An ex-bank clerk disagreed with him ably and successfully on one point of advanced theory, and other subsequent contributors to the discussion who proved well versed in the subject had been respectively a cinema doorkeeper, a grocer's assistant, a classical scholar, a miner, a newspaper reporter, an accountant, a draper's shop assistant, a horse-keeper and two schoolmasters. One of the last had been a teacher of modern languages,

the other of history. One of the best radio trouble hunters I've come across is an ex-policeman; another worked on a poultry farm. And I don't suppose that any of these fellows could have distinguished three years ago between a milliamp and a millimetre! They should go back into civil life, if not as radio professionals, at any rate as radio fans.

A Little Too Far

AT the beginning of the war German radio propaganda was amusing in its threats and exaggerations of any achievements by its Forces. Then it just became boring—a compound of threats and abuse. Now it has reached another stage—the stage of lies so whacking and so palpable that one wonders whether even the gullible inhabitants of the Reich can swallow them. "The important railway junction of Southwold" was pretty good. That pleasant little town never had more than a single-line light railway and for many years it hasn't had a railway at all. And what about "the great seaport of Ipswich, so big that it is used as an alternative to London"? With things of that kind flung out at every opportunity the German radio broadcasts have just become so exasperating that one cannot listen to them. If I tune them in at all nowadays it is to see what they have to say about some event of which I have first-hand knowledge. After a minute or so I move on to something else, wondering what kind of mugs they take their listeners for.

"Universal Circuits"

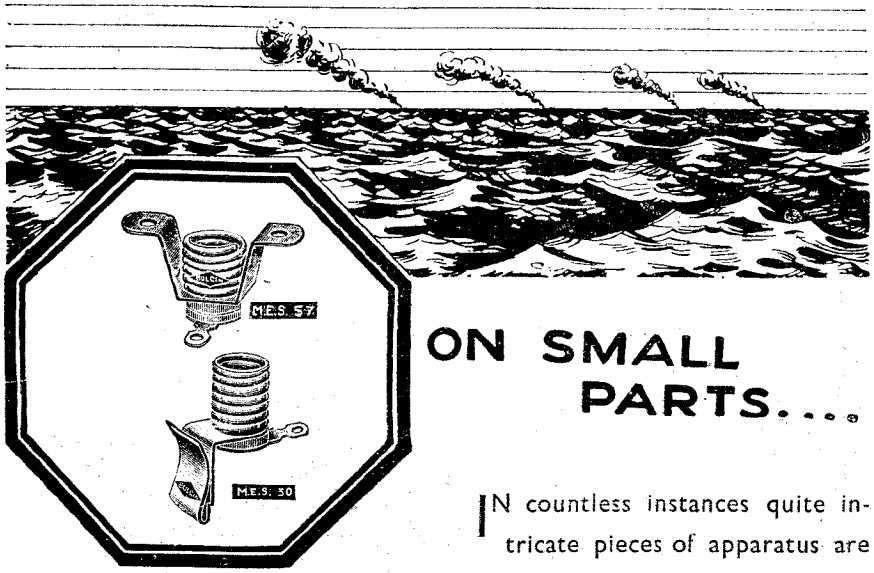
Diagrams Dissected for Study

ONE of the most useful attainments for wireless men is the ability to grasp the essential features of a circuit diagram at a glance. Familiarity with circuits does not in itself imply a deep fundamental knowledge of wireless technique, but it does constitute a most useful foundation for a practical working knowledge of the subject.

A novel idea for facilitating the study of circuit diagrams is embodied in "Universal Circuits," by R. S. Roberts. The publication comprises a 36-page booklet of explanatory text with separate coloured circuit charts of a transmitter, a TRF receiver and a superheterodyne. The charts are provided with a number of fold-up flaps on which various sections of the circuit are printed to register with the main part. Different circuit arrangements can thus be studied; for instance, four different systems of modulation are shown on the transmitter chart. Tracing of the various circuits—AF, RF, etc.—is facilitated by the use of a colour code.

"Universal Circuits" costs 6s. 3½d. by post from the Northern Polytechnic, Holloway, London, N.7.

COMMUNICATIONS DEPEND....



ON SMALL PARTS....

IN countless instances quite intricate pieces of apparatus are wholly dependent on the proved reputation and reliability of their component parts.

All products from the House of Bulgin are pre-eminent for superior design and workmanship and every article bearing our Trade Mark has to pass exacting and exhaustive tests during the course of its production.

We ask the kind indulgence of the Trade on delivery until peaceful conditions return.

The Choice of Critics

BULGIN FOR LAMPHOLDERS

The largest and most extensive range in the World. All kinds of lamp-caps are accommodated, including M.E.S. and E.S., to B.S.S.98, and M.B.C. (the new miniature bayonet cap, single-contact). In the large range there is a full choice of fixing-brackets, -strips, and -clips both 'live' and 'dead.' The screw types are made in rolled, drawn-and-embossed, spring-grip, etc. A lampholder for every use.

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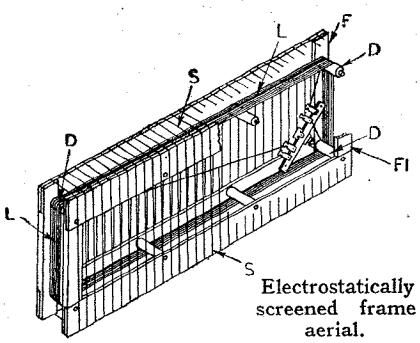
TEL.: RIPPLEWAY 3474 (4 lines).

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

FRAME AERIALS

A FRAME aerial suitable for mounting inside the cabinet of a broadcast receiver is combined with a transverse winding which serves as an electrostatic screen against local fields of disturbance. As shown, the aerial windings L are taken over dowel-pins D projecting from a pair of skeleton frames F, F1, and the screening wires S are wound over the outside of the frames at right angles to the two longer sides of the aerial. The screen winding may be earthed at one or other of its ends, or preferably at its



Electrostatically screened frame aerial.

midpoint, so as to reduce its average impedance to ground.

Philco Radio and Television Corp. (Assignees of W. H. Grimditch.) Convention date (U.S.A.), 5th June, 1939. No. 541905.

ELECTRONIC RESONATORS

IN the Klystron oscillator, waves of the order of centimetres are generated by first passing a stream of electrons through a hollow resonator chamber which serves to "modulate" the velocity of the electrons so that they become bunched along the length of the stream. The stream, in this condition, is then passed through a second similar resonating chamber. This serves as a load circuit to which the bunched stream delivers power.

If the second resonator is back-coupled to the first, the system will build up continuous oscillations which are not subject to the same transit-time limitations as the ordinary valve. The back-coupling is usually effected by a metallic loop or link between the two resonators, but since this is mounted inside the evacuated tube it is difficult to adjust it to feed back in correct phase.

According to the invention the back-coupling link takes the form of a second auxiliary stress of electrons which is of much smaller dimensions than, and flows through the same resonator chambers in the opposite direction to, the first or primary stream. The phase and intensity of the feed-back can then be flexibly adjusted by controlling the voltage on one or more of the electrodes of the auxiliary stream.

Standard Telephones and Cables, Ltd., and W. T. Gibson. Application date, 28th May, 1940. No. 541529.

ELECTRON-STREAM DEVICES

IN the so-called Klystron tube, a stream of electrons is subjected to control fields which periodically advance and retard the normal axial velocity of individual electrons so that the originally uniform stream is broken up into bunches or groups which are equally spaced along the axis of the stream and are then used to shock-excite a resonator chamber and so build up oscillations of very high frequency.

The invention is concerned with a somewhat similar technique. Instead, however, of using control fields to bunch the electrons axially, they are subjected to a longitudinal magnetic field and a transverse electrostatic field whereby in one section of the tube they are constrained to move forward in a helicoidal path, the transverse radius of which varies periodically. In a second part of the tube, which is subject to the same control fields, the electrons which are then moving along a helix of increasing diameter, are separated from those moving in a helix of decreasing diameter, and one or other of them is utilised to feed energy into a load circuit.

Standard Telephones and Cables, Ltd. (Assignees. of Le Matériél Téléphonique Soc. Anon.) Convention date (France), 15th June, 1939. No. 541631.

ELECTRON MICROSCOPES

THE apparent brightness of the optical image produced in an electron microscope is increased, and an improved resolution is obtained, by first reducing the size of the image to increase its brightness, and then viewing the reduced image through a magnifying lens.

For instance, the electron stream produced by projecting an optical image on to a transparent photo-electric cathode is first focused by electromagnetic and electrostatic fields so as to produce an image of reduced size on a fluorescent screen at the far end of the tube. This image is then viewed through a lens.

The reason given for the improvement is that substantially the whole of the energy contained in the electron image is concentrated into a smaller area on the screen, with correspondingly greater brightness, while the amount of light gathered by the lens from an image element on the screen increases with the magnification.

Electric and Musical Industries, Ltd.; J. D. McGee; and H. G. Lubszynski. Application date June 27th, 1940. No. 542245.

INTERFERENCE ELIMINATORS

A RADIO-FREQUENCY transformer coupling is adapted to discriminate between the amplitude variations in a carrier wave due to ordinary signals and those due to sudden or impulsive static disturbance, and to eliminate the effect of the latter. Both primary and secondary windings of the coupling are tuned, and each is shunted by a diode. The diode shunting the primary or input coil is automatically biased to a point where ordinary signal modulations have no effect upon it, whereas any impulsive voltage causes it to conduct and so act as a heavy shunt across the input circuit. In other words, it operates as an amplitude-limiting device.

The diode across the secondary coil is associated with a load circuit having a time-constant such that signal fluctuations of comparatively long duration have no effect upon it, whereas comparatively short static disturbances cause it to conduct and so short-circuit themselves. Each shunt diode is stated to accentuate the action of the other, so that the combination acts as an effective "filter" against the type of interference mentioned.

Philco Radio and Television Corp. (Assignees of A. P. Montgomery.) Convention date (U.S.A.), 13th May, 1939. No. 542077.

CONSTANT-Q INDUCTANCE

AN inductance of the variable permeability type is arranged to be tuned over a wide frequency band whilst maintaining a substantially constant "Q" characteristic, i.e., without appreciably altering the ratio of inductance to resistance.

The inductance consists of two coils, one being wound on a former of smaller diameter than the other, so that the two can be telescoped together. In doing so they both move relatively to their respective powdered-iron cores, the latter remaining fixed inside a hollow sleeve over which the movable formers slide.

In the position of maximum inductance the two coils are most widely separated from each other, but each fully surrounds its own powdered core. In the position of minimum inductance, the two coils (which are reversely wound) are completely telescoped over a core of air, the fixed powdered-iron cores then being most widely separated from their respective coils.

Marconi's Wireless Telegraph Co., Ltd. (assignees of A. L. Rosenberg, Junior). Convention date (U.S.A.) July 20th, 1939. No. 542531.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

When the iron is hot . . .

We are striking *now*, to forge the weapons of victory at ever-increasing speed! Weapons as modern as the methods now used to make them. The slow, deliberate art of the armourer and blacksmith has given place to the speed of the electric arc welder. In other ways, too, electrical development has revolutionised our methods; for our armies, our ships, our hospitals and our factories, it has provided the boon of X-rays; the many uses of the sound amplifier; the efficiency of modern lighting; the wonders of radio communication . . . and much more besides. It is an inspiring story of electrical achievement in which the name of PHILIPS is outstanding.

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LAMPS • RADIO • X-RAY AND ELECTRO-MEDICAL EQUIPMENT • DISCHARGE LIGHTING • SOUND AMPLIFYING INSTALLATIONS • ARC WELDING EQUIPMENT AND ELECTRODES

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ADVERTISEMENTS for the August issue are accepted up to First Post on Wednesday, July 8th, at the Head Offices of Dorset House, Stamford Street, London, S.E.1, or one day earlier at provincial Offices.

THE PROPRIETORS retain the right to refuse or withdraw advertisements at their discretion. They are not responsible for clerical or printers' errors although every care is taken to avoid mistakes. Cheques and postal orders should be made payable to Iliffe & Sons Ltd. and crossed. Notes are legal tender and cannot be traced if lost in transit.

ADVERTISERS may have letters, other than circulars, addressed to numbers at this office. The words Box 000, c/o "WIRELESS WORLD" must be paid for and a further 1/- added for registration and forwarding replies.

DEPOSIT SYSTEM. Full particulars upon application to the Deposit Dept., "Wireless World," Dorset House, Stamford Street, London, S.E.1.

Ode

Partridge

No. 17

HOLIDAYS

No more rushing to the seaside,
No more wracking of our brains,
No more searching round for diggings,
No more panting after trains.

No more touring through the country
(No more petrol sees to that),
No more climbing towering mountains,
No more "parking" dog and cat.

No more coming home to gardens
Nature-filled with self-sown seeds,
All the best plants burnt to blazes
Leaving only thriving weeds.

No more "Where shall we go this year?"
Stay at home and do your bit,
Sit and think of others working,
If you *can't* think, well—just sit !"

N. Partridge

Makers of Transformers and Chokes

King's Bldgs., Dean Stanley Street,
LONDON, S.W.1. 'Phone: VICtoria 5035

ARMSTRONG

A very limited supply of

EXP48 COIL PACKS

covering 4-wavebands, have now become available and orders will be executed in rotation whilst our stock lasts

Originally designed for use with our export chassis, Model EXP48, which was so favourably reviewed in the October, 1940, issue of *Wireless World*. The Test Report said: "no difficulty was experienced in picking up American stations." This assembly is ideal for constructing a modern receiver using English or Octal valves, or tuning unit to work with an amplifier. The short-wave performance with the EXP48 coils is extremely high.

Specification. EXP48 coil and switch assembly covering 13-45, 45-160, 200-550, 1,000-2,000 m. Mounted on cadmium plated sub-chassis with 4 position Yaxley type rotary switch. Medium and long wave adjustable padders and fixed padders on the short-wave ranges. Each coil fitted with individual trimmer and the whole assembly wired up. **Factory Blue Print** giving 7-valve EXP48 circuit and values of components FREE with assembly. **Price 35/-. Heavy Steel Chassis** for use with above, 12in. × 9in. × 3½in. deep drilled and cadmium plated. **Price 10/6.**

465 kc. High "Q" I.F. Transformers, Leitz wire wound and fitted with iron cores, in aluminium cans, incorporating trimmers with ceramic insulation. For use with the above. **Price 18/6 per pair.**

Glass Scales, 4 wave-bands, calibrated in station names and metres, For use with the above. **Price 3/6.**

A complete chassis, incorporating the above components, will be gladly demonstrated at our Showrooms and any technical advice given.

Deliveries should not exceed 7 to 10 days.
All components advertised in June issue are still available.

★

ARMSTRONG MANUFACTURING CO.
WARLTERS ROAD, HOLLOWAY, LONDON, N.7
'Phone: NORth 3213

Advertisers and buyers are reminded that under Defence Regulations 1939, Statutory Rules and Orders 1940, Number 1689, a permit (T 99 G) must be obtained before sale or purchase of certain electrical and wireless apparatus, particularly such valves and apparatus as are applicable to wireless transmission.

RECEIVERS & AMPLIFIERS—SECONDHAND, ETC.

R.M.E. 69 and Speaker, black crackle, perfect; nearest £50.—57, Briarlands Ave., Sale, Cheshire. [1111

"W.W." V Selectivity IV, needs repairs; wanted, Avometer, Avodapter.—7, Chapel St., Portmadoc. [1090

10v. Crosley, 18v. Mid-West, 5 bands, chassis and speakers; offers.—Minor, 18, Broad Park, Exmouth. [1097

W. WORLD quality, Superhet Unit with valves, £7/10; Varley Permeability Tuner, with 2 var., I.F.S., £1/10, A.F.5 8/-; all perfect.—Nightingale, 113, Stockton Rd., Darlington. [1079

CONNOISSEUR in Services Invites Offers for 2 Magnificent Autoradiograms, 1939 Keates Hacker; cost £298; Philco De Luxe 1938 22-valve, cost £132; consider selling chassis, changers, cabinets, separate.—Box 2690, c/o *Wireless World*. [1096

Wanted

TROPHY 6, good condition.—Particulars and price, Poulter, 26, Oakbury Rd., London, S.W.6. [1071

PRESELECTOR DB 20 or Peak. Describe quoting sensible price.—Box 2686, c/o *Wireless World*. [1080

SECONDHAND Microphone and Amplifier, under £8; urgent.—Apply Riley, Michell House, Rugby. [1075

WE Offer Cash for Good Modern Communication and All-wave Receivers.—A.C.S. Radio, 44, Widmore Rd., Bromley. [9948

WANTED, high fidelity receiver, 5-6watts output, and speaker.—"Fairfield," Sandford Mill Rd., Cheltenham. [1115

WANTED, Hallicrafter Sky-Champion or other similar receiver.—Write, giving price, particulars, de Mierre, 14, The Tything, Worcester. [1114

NEW or Used Receivers, Amplifiers, Meters, Converters, Radio & Electrical Accessories. Very high prices paid for really clean apparatus.—'Phone: Gerrard 4447. [9696

LONDON CENTRAL RADIO STORES Will Pay good prices for Receivers, Radiograms, Amplifiers, Dynamos, Converters, Test Equipment, Electric Gramophone Motors, and all Radio and Electrical Accessories.—London Central Radio Stores, 23, Lisle St., London, W.C.2. Gerrard 2969. [9836

NEW LOUDSPEAKERS

BAKERS SELHURST RADIO, the pioneer manufacturers of moving coil speakers since 1925.—Bakers' brand new surplus speaker bargains; every music lover interested in realistic reproduction should write for free descriptive leaflet now; £3/10, brand new super quality triple cone speaker, permanent magnet model; limited number available under list price, wide frequency range, even response, ideal for quality reproduction; leaflet giving constructional details of an infinite baffle cabinet suitable for use with the above speaker free upon receipt of stamp.—Bakers Selhurst Radio, 75, Sussex Rd., South Croydon. [1101

SECOND-HAND LOUDSPEAKERS

VOIGT Twin; offers.—Pearson, Coupe Green, Hoghton, Lancs. [1109

VOIGT H.C. horn only. What offers?—Rushton, 42, Broad Walk, Wilmslow. [1076

BAKER Speaker, 1,250 ohms fd., curved 10in. cone, £5/5, plus carr.—Goldthorpe, 46, Meadow St., Rotherham. [1107

Wanted

EARL P.M., with Transformer.—Box 2693, c/o *Wireless World*. [1110

HALLICRAFTERS 12in. PM-16 Dynamic Speaker and Cabinet.—Price, details, 14, Common Rd., Evesham. [1091

QUALITY Speaker and Telefunken Pick-up.—Details and price, Beattie, Raikes Rd., Skipton. [1094

ROLA G12 M.C. Spkr., preferably P.M., with or preferably without trans.—A. G. Forsyth, The Toft, Dormansland, Surrey. [1086

ELECTRADIX

DYNAMO BARGAINS. Lucas-Rotax 6/12-volt, 8 amps., D.C. 3rd brush, size 8in. by 4½in. dia., aero weight 11 lbs. For pulley or wind drive O.K. Cost £10. Sale, **15/-.** Hundreds of other dynamos in stock.

G.E.C. DOUBLE CURRENT DYNAMOS. 6 volts and 600 volts, ball bearings 17 lbs., **25/-.**

SWITCH BOXES. Lucas 8-way change-over and fuses, metal cover, **3/6.** 6-way Push-button Switches, R.A.F. aero type, **2/9.** Rotary Switches, R.I., 7-stud, boxed, **7/6.**

A.C./D.C. MAINS MAGNETS. 2 wound poles, 110/220 volts, 7 lbs. lift, **5/6.** Magnet Drop Indicators, 2 volt, 2½ ohm bobbin, hand reset for bell calls, etc., or relay indicator, **2/6.**

SOLENOIDS for remote control, etc., 12 volts, ¼in. plunger, 2in. long, compound wound, **6/6.**

CIRCUIT BREAKERS. Various ranges, 1½ amps. to 10 amps. magnetic trip, ironclad, **25/-.** Switchboard Breakers, 300 amp., cheap.

VARIABLE AIR CONDENSERS. S/W, .0005 mfd., Type F in Maker's carton, **3/6.** Twin Trimmers on ceramic, .00012 to .00015 mfd. **8d.** pair.

FIXED CONDENSERS. 2 mfd., G.P.O., **2/6.** H.T. mica, ½ mfd., 4,000 volts, compact, **10/-.** Large, 1 mfd., 2,000 volts, **10/6.** 1 mfd. 6,000 volts, oil filled B.I Condensers, **35/-.** 2 mfd., 4,000 volts, cased, **45/-.**

INSULATORS. Large variety of all shapes and sizes, from egg and shell for aerials to big Navy deck, cable cleats and pedestal. No lists left, please specify wants.

GALVOS., ETC. Circuit testing, G.P.O., vertical, **35/-.** Elliott, etc., Army £108 in case with test rheo., M.C. meter, m/a. to 3 amps., **57/6.** Bridge Galvos., Sullivan Marine Mirror Galvo., vertical suspen., M.C. **£9/10/-.** Tinsley Ballistic Susp. Coil Mirror Galvo., as new, **£4/10/-.** Wheatstone Bridges, incomplete, G.P.O. surplus, less coils and plugs, **45/-.**

VALVES. General-purpose robust valves at a low price. "Weco" Peanut Midgets, 1-volt fila., 4-pin base, **3/6.** Cossor 6-volt Power Valves, AT40, **4/6.** Both these are Triodes. Neon Lamps, standard size, letter Cathodes, 230 volts, **2/6.**

RELAYS. Single-pole No. 4A on-off, 2-volt, 'phone type, **5/-.** No. 6 Relay Twin Bobbin, 6 volts, 25 m/a., S.P.C.O., **8/6.** Electric Counters to 9999, **5/-.**

POCKET CLINICAL THERMOMETERS, in metal case, useful in the Service, **2/6.**

FIELD 'PHONE CABLE. Single or twin. In half mile reels.

CEILING ROSES. Porcelain, with 2 Scruit couplers, make good connect. boxes, **6/6** doz.

EDISON STEEL CELLS. A.8, in stock, **35/-.**

WAVEMETERS, ETC. Buzzer and Heterodyne, less calibration charts, **45/-** to **£3/10/-.** Radiogoniometer Direction Finders, **£4/10/-.** Fultograph Spares, new. Chart Drum and Clip, **5/6.** Magnetic Clutch, 6-volt, complete, **25/-.** 9in. Traverse Shaft, 4in., threaded 120 to inch, with bearings, **12/6.** Stylus with carriage rods and brackets, **7/6.** 5-pin Plugs with panel socket and cords, midget type, pair, **4/6.** ⅛in. Drilled Alumin. Panel, 13in. × 6⅝in., **3/-.** Bakelite, ditto, 7⅞in. × 6⅝in., **2/3.**

AMPLIFIERS. Ex W.D. Portable, Mark IV 3-valve Battery Amplifiers. 9in. × 9in. × 6½in., double doors, mahogany canvas-covered metal-bound case. Fitted 4 transformers, 5-tap switch rheo., terminals and sockets. Suitable for conversion for test set mike amplifier, oscillator, etc., unused, **45/-.**

WORKS SWITCHBOARD PANELS. Fitted circuit breakers, meters and switches. Price on application.

MEGGERS, MORSE INKERS, GALVOS., WHEATSTONE BRIDGES, KEYS, BUZZERS, FIELD TELEPHONES, CABLE, GENERATING SETS, AND ENGINES.

CRYSTAL SETS. Need no batteries or mains. Model "B," mahog. case with coils for Broadcast, **15/-,** post free.

TURNTABLES. Bakelite 4½ in. diameter steel ball bearings. 2/- post free.

Postage must be added to all mail orders.
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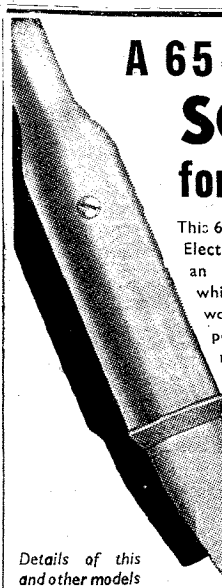

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VOLUME controls, Sator ⅜ meg. with switch, short spindle, 2/3 each. British made 5,500 and 10,000 less switch, medium spindle, 2/3 each, not more than two per customer (few only in stock).

SPECIAL Note.—We now confine our business to Mail Order; prompt attention, in rotation.—G. A. Ryall, "Arnehurst," Marsh Lane, Taplow, Bucks. [1085

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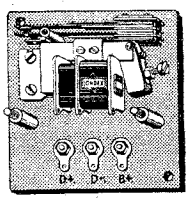

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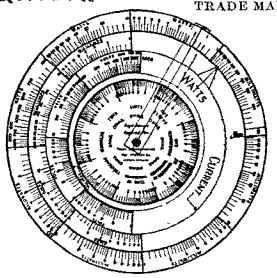

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What will be the resistance where watts W is at voltage E?
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AMERICAN AND INTERNATIONAL OCTAL. Mostly glass types 1A4, **12/6** ; 1A6, **14/-** ; 1J5, **15/-** ; 1C5, **16/-** ; 1G5, **15/-** ; 2A6, **14/-** ; 2A7, **15/-** ; 2B7, **15/-** ; 5Y3, **14/-** ; 5Z4, **14/6** ; 1V, **12/-** ; 6A8, **14/-** ; 6AG5, **11/6** ; 6AC5, **11/6** ; 6B7, **14/-** ; 6B8, **16/-** ; 6C5, **13/-** ; 6C6, **14/-** ; 6D6, **14/-** ; 6D7, **15/-** ; 6F5, **12/-** ; 6F7, **17/-** ; 6J5, **13/-** ; 6J7, **13/-** ; 6K7, **13/-** ; 6K8, **14/-** ; 6L7, **13/-** ; 6Q7, **13/-** ; 6S7, **14/-** ; 6U5, **11/-** ; 6U7, **13/-** ; 6V6, **13/-** ; 6X5, **15/-** ; 6Z5, **18/-** ; 7V3, **16/-** ; 7Y4, **11/-** ; 12B8, **15/-** ; 15, **18/-** ; 19, **18/-** ; 24A, **13/-** ; 26, **11/-** ; 27, **9/-** ; 31, **12/-** ; 32, **15/-** ; 33, **14/-** ; 34, **15/-** ; 35, **13/-** ; 36, **14/-** ; 37, **11/-** ; 38, **12/6** ; 39/44, **12/6** ; 46, **15/-** ; 47, **14/-** ; 50, **25/-** ; 53, **16/-** ; 52, **22/-** ; 55, **13/-** ; 57, **14/-** ; 58, **14/-** ; 59, **16/-** ; 71A, **11/-** ; 76, **10/-** ; 77, **15/-** ; 79, **15/-** ; 80, **14/6** ; 83, **18/-** ; 84/6Z4, **14/6** ; 85, **12/-** ; 2101, **15/-** ; 2103, **15/-** ; 2151, **14/-**.

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RESISTERS. 10 watt up to 2,000, **2/6** each.

VOLTAGE DROPPERS for most sets, from **4/6** each.

C.I. & C.I.C. replacements resisters, **6/-** each.

CONNECTING WIRE, 2/- ½ lb. reel, sleeving suitable for above, **4d.** yd. **SOLDER,** resin cored, **5/6** lb. or **1/-** coil.

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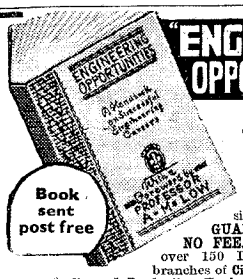

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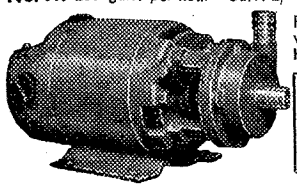

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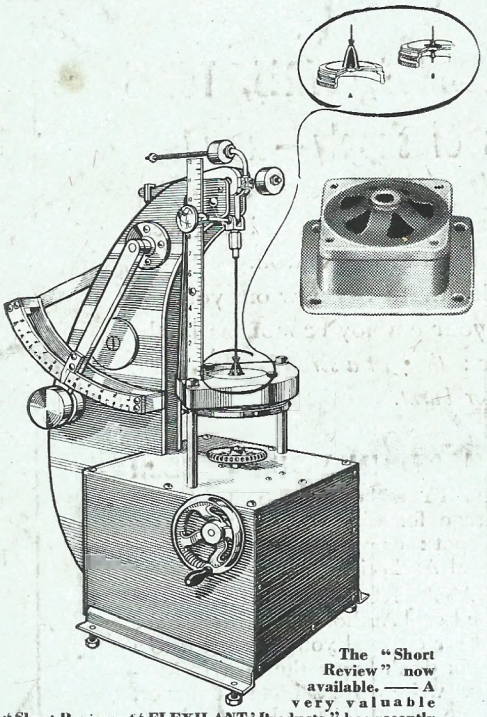

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